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SYNCRO/RESOLVER

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OPERATING AND INSTRUCTION MANUAL

RESOLVER-SYNCHRO SIMULATOR

MODEL 530 S-1634

NORTH ATLANTIC

industries, inc.

OPERATING AND INSTRUCTION MANUAL

RESOLVER-SYNCHRO SIMULATOR

MODEL 530 S-1634

NORTH ATLANTIC INDUSTRIES, INC.
Hauppauge New York

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NORTH ATLANTIC industries, inc.
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CAUTION

High voltage exists at several points in the instrument. Normal precautions consistent with good practice should be taken to reduce shock hazard.

A potential shock hazard exists when ungrounded power source or ungrounded case operation is employed. Persons operating the instrument should be made aware of and take precautions against this condition.

North Atlantic Industries, Inc. cannot be held responsible for damage to person or property in the process of or as a result of maintenance, calibration, or setting up of the instrument.

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SECTION I

GENERAL DESCRIPTION

North Atlantic Resolver/Synchro Simulators provide, in one compact 5-1/4" bench or rack-mounted unit, the ability to generate the electrical data of angular shaft position of either three-wire synchros or four-wire resolvers to an accuracy of 10** seconds of arc.* The Model 530 is a dual-mode Resolver-Synchro Simulator.

This unit meets all of the requirements for use in providing ideal inputs for testing synchro and resolver receivers, or systems under test or evaluation which operate from synchro or resolver signals. In addition to their respective mode capabilities, all standard units provide switch selected line-to-line voltages of 11.8, 26, 90 or 115 volts, from either 26V or 115V input excitation. Consequently, any of the instruments in this series may be used for testing any standard synchros or resolvers as well as systems using these components.

Instruments in this series are designed to provide full specified accuracy at 60Hz, 400Hz, and 10KHz. These instruments may be used over the entire band of 50Hz to 11KHz with reduced accuracy. Specified accuracy is maintained for all angles over the complete range of readout. Similarly, loading errors which might arise from output impedance unbalance are minimized due to a high degree of impedance match coupled with a low output impedance.

Caution should be exercised when applying reference to this unit in order not to exceed its maximum f rating specification.

*Accuracy of all North Atlantic Resolver/Synchro Simulators are verified by comparison to Ratio Standards which have records of calibration traceable to the National Bureau of Standards.

**20 seconds of arc at 10KHz.

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Model options for all Simulators include a 6 knob, .0001° resolution and a 5 knob, .001° resolution version for full-rack mounting. Available for half-rack or full-rack mounting are a 2 knob, 1° resolution and a 1 knob, 5° resolution version. All models have in-line display for angular decimal readout, and are continuously switched through 360°.

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MODEL 530

RESOLVER-SYNCHRO SIMULATOR

GENERAL SPECIFICATION

The following specification applies to all North Atlantic Resolver-Synchro Simulators. Where a special modification or variation is involved, the governing specification will either be a separate specification control document, the buyer's purchase order, or a supplement contained in this manual. Specifications for special instruments are identified by the "S" number appearing on the instrument's nameplate.

Series 530 are dual mode Resolver-Synchro Simulators.

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ELECTRICAL SPECIFICATIONS

Modes of Operation:	60 Hz Synchro 400Hz Synchro 400Hz Resolver 10KHz Resolver
Frequency:	60Hz Synchro Mode - 50Hz to 1200Hz 400Hz Synchro Mode - 200Hz to 800Hz 400Hz Resolver Mode - 200Hz to 800Hz 10KHz Resolver Mode - 10KHz ±10%
Excitation Voltage:	60Hz Synchro - 115V Nominal 2f VRMS to 170V max (f = Hz) 400Hz - 115V Terminal: 115V nominal, 2f VRMS to 170V max (f = Hz) 400Hz - 26V Terminal: 26V nominal, 0.5f VRMS to 40V max (f = Hz) 10KHz Resolver - 115V Terminal: 115V nom. 0.05f VRMS to 170V max (f = Hz) 26V Terminal: 26V nom. 0.012f VRMS to 40V max (f = Hz)

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Output Voltage: 600Hz Synchro - 90V L-L only. All other Modes: 11.8V L-L, 26V L-L, 90V L-L, and 115V L-L

Accuracy: (Unloaded) 60Hz and 400Hz = ±10 sec. 10KHz = ±20 sec.

Max. Eff. Output Impedance Unbalance

	11.8V	26V	90V	115V
Synchro 60Hz			.05+J.03	
Synchro 400Hz	.01+J.01	.01+J.01	.05+J.03	.05+J.03
Resolver 400Hz	.01+J.01	.01+J.01	.05+J.03	.05+J.03
Resolver 10KHz	.025+J.025	.025+J.025	.125+J.125	.125+J.125

Isolation:

Resolver Modes: S1, S3, and S2, S4 windings are transformer isolated from each other and the excitation.

Synchro Modes: S1, S2, S3 outputs are transformer isolated from the input.

Conventions:

Resolver: In accordance with MIL-R-21530

Synchro: In accordance with MIL-S-20708A

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SECTION II

INSTALLATION

The North Atlantic Series 530 and 540 Resolver-Synchro Test Equipment is designed for either rack mounting or bench use. The compact 5-1/4" height and standard relay rack width allow installation into a large variety of test consoles with a minimum sacrifice of space. The all passive circuits used generate no heat and, therefore, no space need be allocated for cooling purposes.

The bench model option consists of a standard relay rack model with the addition of a bezel and end piece assembly. For conversion to relay-rack mounting, these pieces may be removed and rack-mounted as shown in the frontispiece.

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SECTION III

OPERATING PROCEDURE

Excitation Terminals, Fuses, and Line-to-Line Level Selector

Power is applied to the Simulator at either the front or rear excitation terminals. The high side of the excitation should be applied to either the 115V or 26V excitation terminal, depending on the level being used. (See Specification Sheet for voltage limitations.) The ground side of the excitation should be attached to the terminal marked "COM." The case should be placed at ground potential by either the rack-mounting connection or a jumper from the "COM" terminal. The unit is protected by a 1 ampere and a 2 ampere fuse in series with the 115V and 26V excitation lines, respectively. These fuses are located on the front panel. A third fuse protects the internal trigonometric transformers.

The line-to-line selector located on the front panel provides a choice of four different line-to-line levels: 11.8V, 26V, 90V*, and 115V, independent of mode and turns the unit off. These levels will be obtained with either 26 volts or 115 volts excitation (applied to their respective excitation terminals).

Mode Switch and Output Terminals

The Mode Switch located on the front panel (Model 530 only) allows the user to select synchro or resolver modes for 60Hz, 400Hz, or 10KHz. In the Synchro Mode (Model 530), three-wire synchro data is available from the synchro terminals on the rear panel, as well as from the output terminals on the front panel. Half-rack models, unlike the full-rack versions described above, have only rear terminals.

Synchro mode is available for 60Hz and 400Hz and resolver mode is available for 400Hz and 10KHz.

*90V line-to-line is the only level available in the "60Hz Synchro" Mode.

Decade Angle Switches and In-Line Decimal Readout

The electrical angular setting of the Simulator is adjusted by means of the angle selector knobs located on the front panel. The angle is read directly above these controls.

The first switch controls the most significant digit and advances the angle by 5° steps in 5° resolution models and 10° steps in all others. This switch is continuous (no stops) enabling the user to go directly from 350° to 0°. The second switch controls the units from 0° to 9°. The third and fourth switches (in the high resolution models) control tenths and hundredths of degrees, respectively. The fifth control provides thousandths of a degree resolution.

In the .0001° Model 5-knob, two concentric switches are provided: the inner for increments of .001° with its readout in the window above the switch and an outer knob for increments of .0001° with its indicated setting screened on the panel.

Applications

There are many methods in which a Simulator can be used as a test instrument for the evaluation, calibration, and alignment of Resolver and Synchro components, as well as systems employing these components. The following examples are meant to serve as a guide only. Many other applications in such areas as control

circuit, phase shifters, etc., will no doubt occur to the user once familiar with the instrument's capability.

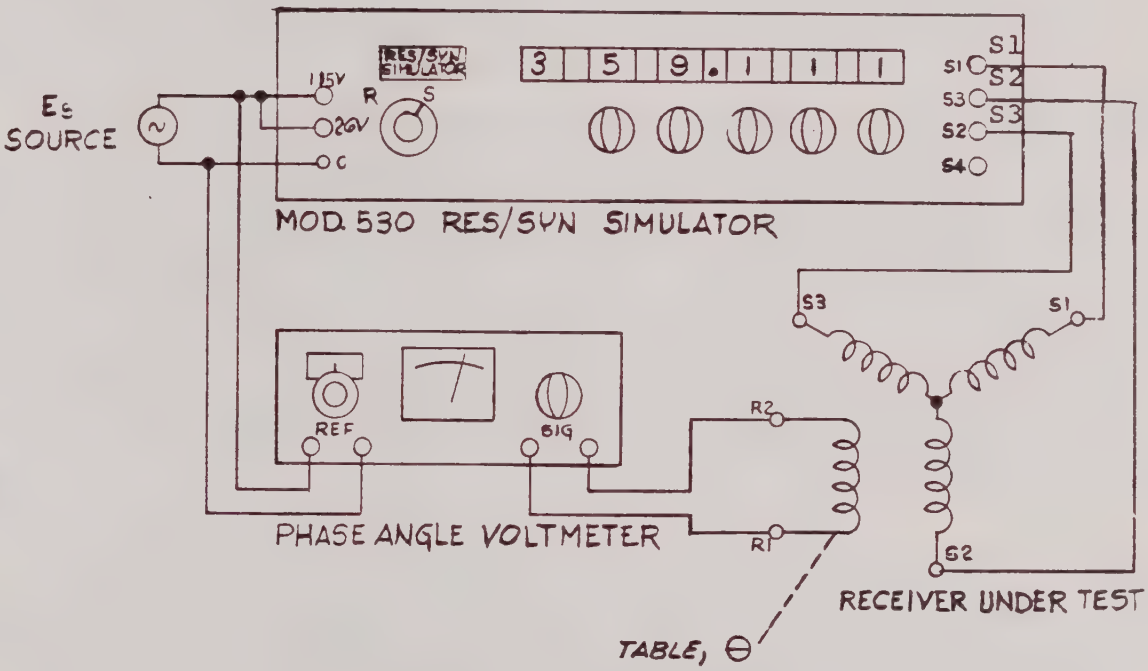

FIGURE 3
TYPICAL TEST HOOK-UP FOR TESTING A SYNCHRO CIRCUIT

Finding the Unknown Data Angle of a Receiver Type Component Using a Full Resolution Simulator

With a circuit hookup similar to that shown in Figure 3.1, adjust the Simulator angle select knobs to produce an approximately in-phase null on the Phase Angle Voltmeter. The null meter phase shifter should be set at 0°.

Since the Resolver or Synchro Receiver under test will have two positions which yield an in-phase null, it is necessary to remove this ambiguity as follows:

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While in the region of an approximate null, increase the angle setting of the Simulator. This will produce a more positive deflection on the Phase Angle Voltmeter, if the correct angle has been found and if conventions are in accordance with Section IV of this Manual. If the reading is negative, increase the setting of the Simulator by 180° and verify that the correct gradient polarity now occurs.

Proceed with the nulling process by using the highest increment knobs first and continuing to the least significant knob. It will be necessary to down-scale the Phase Angle Voltmeter while these adjustments are being made in order to obtain maximum sensitivity.

In the above measurement, it was indicated that the phase shifter of the null meter was set at 0° so as to produce a null in-phase with the line excitation. This method is consistent with the procedures of MIL-S-20708A.

An alternate null detector phase setting is sometimes used when the source of the null detector reference has an arbitrary phase relation to the synchros resolver excitation or where the component usage requires phasing in relation to the actual output signals. This procedure which is required by definition in MIL-R-21530C Resolvers, is as follows:

With a (0° phase) null achieved as above, switch the Simulator to maximum output (90° + reading). Up range the null meter and observe the quadrature component at as large a meter deflection as possible. Now, offset the Simulator by a large angle, but not enough to light the meter overload lamp and observe that the quadrature reading changes slightly. The Phase Dial is now re-positioned so as to restore the original quadrature

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reading. This, in effect, aligns the system to make measurements in-phase with the output. Since the actual setting would vary somewhat with mechanical position of the component under test, this procedure is usually done at zero mechanical degrees of electrical zero.

Adjusting a Receiver or System to a Predetermined Angle

With the Simulator connected to provide an input to the receiver under test, set the Angle Selector Knobs so as to adjust the Simulator to the desired angle. Then adjust the receiving resolver or synchro to obtain a null on the output of the receiver as evidenced either by an external Phase Angle Voltmeter (see Figure 3 or by some pre-established output of the system being aligned. For example, if a servo such as a North Atlantic API-8025 were being tested, the counter readout would be used to indicate the null position of the receiver shaft.

At this point, increasing the Simulator angle will cause a positive change in resolver or synchro data and in the case of a system under test will cause the system output to increase providing the system or components are wired in accordance with the conventions of Section IV. If an opposite deflection occurs, the receiver being aligned is 180° in error and should be repositioned by this amount.

Note that in systems incorporating resolvers and synchros, the conventions of Section IV are frequently altered to provide fixed offset angles or to reverse direction of rotation. The user must, therefore, verify the nature of the system's performance requirements before

interpreting the results of the foregoing test.

Using the Phase Angle Voltmeter for Measuring Receiver Angular Error

This method is frequently used in testing synchro or resolver receivers where the inputs are in the form of discreet shaft angle increments. Typically, a component under test would be mounted in a device such as a dividing head. The Simulator and dividing head would be set to 0° and the component positioned to 0° angle in the manner described in the previous paragraphs or by the electrical zero method of the applicable military specifications. Both the Simulator and the dividing head are then advanced in the desired increments. The amplitude of the null voltage as measured on the output of the receiving component is related to the error angle as follows:

$$E_{out} = K \sin(\theta - \phi)$$

$$\cong K(\theta - \phi)$$

Where: K is gradient of device under test

$(\theta - \phi)$ is error angle of component

Since this relationship holds for small deviations at all angular settings whether the component is a resolver or a synchro, the null meter can easily be used to read a voltage which is proportioned to degrees, minutes, or seconds of arc.

As a matter of added convenience, a Phase Angle Voltmeter having a variable range attenuator will permit the user to scale the null meter sensitivity such that the error angle can be read directly in degrees, minutes, or seconds from the meter itself.

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SECTION IV

CONVENTIONS

Conventions for polarities, terminal designation, and direction of shaft rotation for synchros and resolvers are most frequency defined in accordance with military specifications MIL-S-20708A (synchros) and MIL-R-21530 (resolvers).

North Atlantic Bridges and Simulators all have terminal designations and electrical characteristics consistent with these same specifications. Thus, a Bridge is used as though it were a receiving component such as a control transformer (CT or RC). Likewise, a Simulator is comparable to a transmitting component (CX or RX).

In applying the conventions, caution must be exercized that:

1. The manufacturer of the synchro or resolver followed the mil-spec conventions.

2. System use of the component has not dictated a change in convention in order to achieve a difference in characteristic such as direction reversal or mechanical shaft offset.

Synchro Transmitter Conventions

Synchro Transmitter (CX)

The equations describing an ideal Synchro Transmitter (CX) apply as well to all Series 530, 532 Simulators. They are:

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$$E_{(S1-S3)} = NE_{(R2-R1)} \sin\theta$$

$$E_{(S3-S2)} = NE_{(R2-R1)} \sin(\theta + 120°)$$

$$E_{(S2-S1)} = NE_{(R2-R1)} \sin(\theta + 240°)$$

Where: $E_{(R2-R1)}$ is the voltage between rotor leads R1 and R2

$E_{(S3-S2)}$ is the voltage between stator leads S1 and S2. Other voltages are similarly defined.

N is the ratio of the maximum rms voltage between the secondary terminals (stator) and the primary rotor voltage.

θ is the shaft angle displacement from electrical zero which satisfies these equations.

The schematic representation for a Synchro Transmitter (CX) is shown below in Figure 4.1

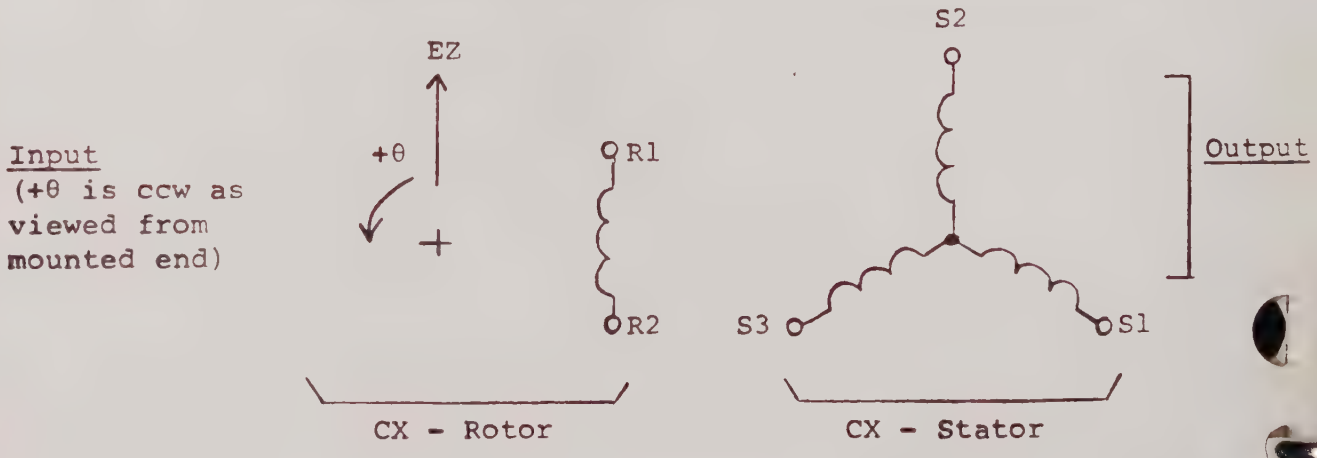
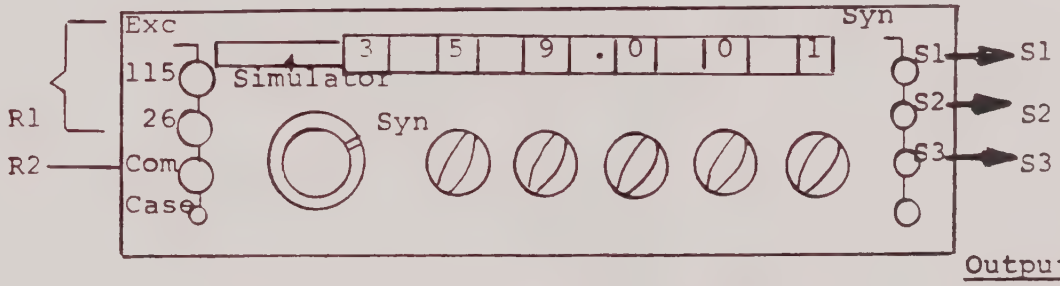


Figure 4.1 - Synchro Transmitter (at EZ) - CX

NOTE: Synchro is shown at $\theta = E_Z$ (electrical zero). This is defined as that angle for which coupled voltage between the rotor and E (S1-S3) is a minimum.

SYNCHRO SIMULATOR

The input and output terminals of the North Atlantic 530 and 532 simulators correspond to the above diagram and are indicated below in Figure 4.2.



Input
From Exciting Source

Output
To Synchro CT or CDX

Figure 4.2 - Model 530 Simulator (Synchro Mode)

Synchro Receiver Convention

Synchro Receiver (CT)

The equations describing an ideal synchro receiver or control transformer (CT) apply as well to all Series 540 and 541 Bridges. They are:

$$E_{(R2-R1)} = N\left[E_{(S3-S2)} \sin\theta - E_{(S1-S3)} \sin(\theta + 120)\right]$$

$$0 = E_{(S1-S3)} + E_{(S3-S2)} + E_{(S2-S1)}$$

Where: Symbols have meaning defined above.

The schematic representation for a synchro-receiver (CT) is shown below in Figure 4.3.

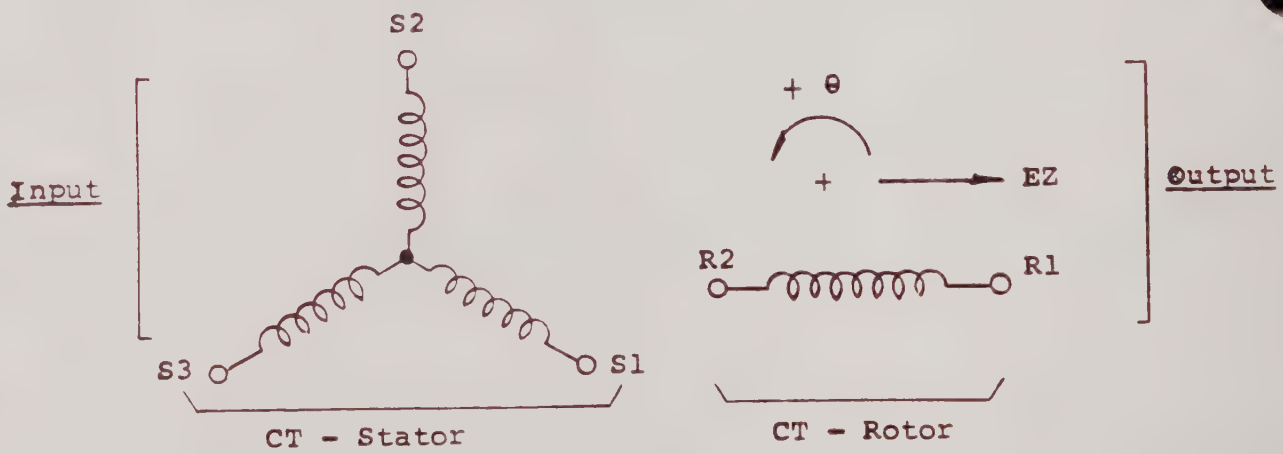


Figure 4.3 - Synchro Receiver (at EZ) - CT

NOTE: Synchro is shown at $\theta = \theta_Z$ (electrical zero). This is defined as that angle for which the coupled voltage to the rotor is a minimum when the stators are excited between S2-S1, S3.

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Synchro Bridge

The input and output terminals of a North Atlantic Series 540 and 542 Bridge an analgous to those of a synchro receiver (CT). The connections which correspond to the above are shown in Figure 4.4.

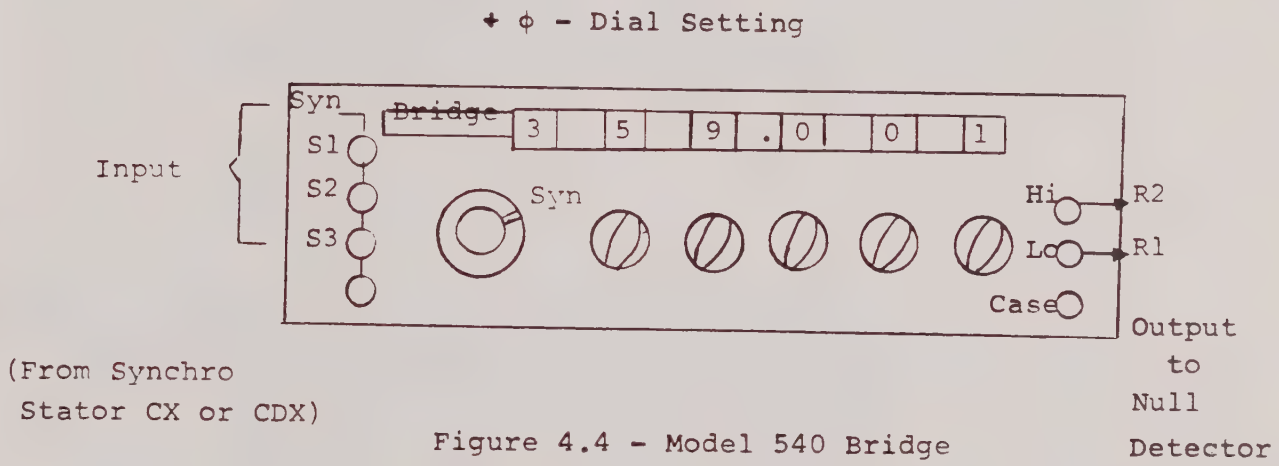


Figure 4.4 - Model 540 Bridge (Synchro Mode)

Resolver Conventions

Resolver Transmitter (RX), Control Transformer (RC), and Differential Resolver (RD)

The equation describing an ideal resolver apply as well to all Series 540 and 541 Bridges and

530 and 531 Simulators. They are:

For Rotor Energized Resolvers:

$$E_{(S1-S3)} = NE_{(R1-R3)} \cos\theta - NE_{(R2-R4)} \sin\theta$$

$$E_{(S2-S4)} = NE_{(R2-R4)} \cos\theta + NE_{(R1-R3)} \sin\theta$$

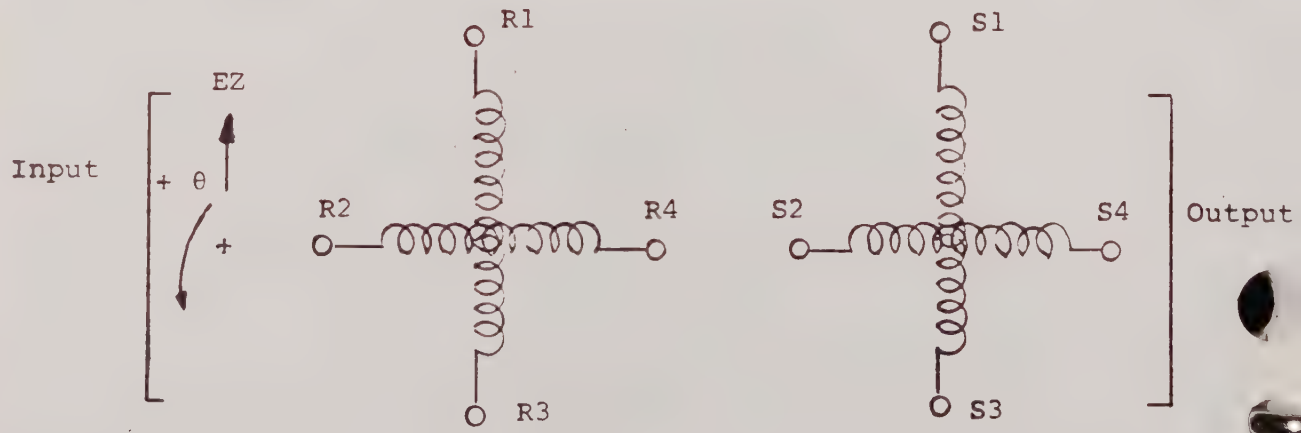
For Stator Energized Resolvers:

$$E_{(R1-R3)} = NE_{(S1-S3)} \cos\theta + NE_{(S2-S4)} \sin\theta$$

$$E_{(R2-R4)} = NE_{(S2-S4)} \cos\theta - NE_{(S1-S3)} \sin\theta$$

Where: Symbols have meaning defined above.

The schematic representation for a Resolver Transmitter (RX), Resolver Control Transformer (RC), or a Differential Resolver (RD) with the rotor excited is shown below in Figure 4.5.
Input and output can be reversed for stator excited schematic.



(+θ is ccw as viewed from mounted end)

Figure 4.5 - Rotor Excited Resolver at EZ, RX, RC, or RD

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NOTE: Resolver is hown at θ = EZ (electrical zero). This is defined as a minimum coupling from (R1-R3) to S2-S4) for rotor excited case. For stator excited resolver EZ is defined for minimum coupling from (S1-S3) to (R2-R4).

Resolver Simulator

The input and output terminals of a North Atlantic Series 530,531 Resolver Simulator are analgous to those of a rotor excited Resolver Transmitter (RX). The connections which correspond to those shown in the diagram of 4.5 are illustrated below in Figure 4.6 for a Model 530 Simulator in the Resolver Mode.

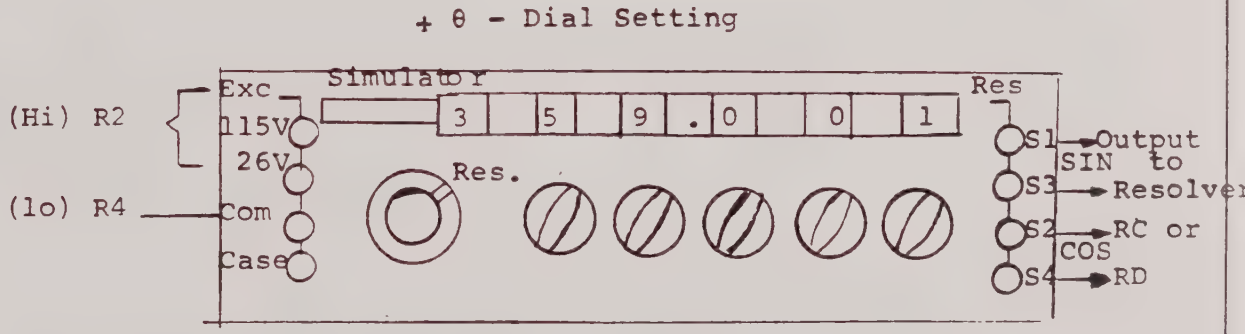

FIGURE 4.6 - Model 530 Simulator Resolver Mode

Input From Exciting Source

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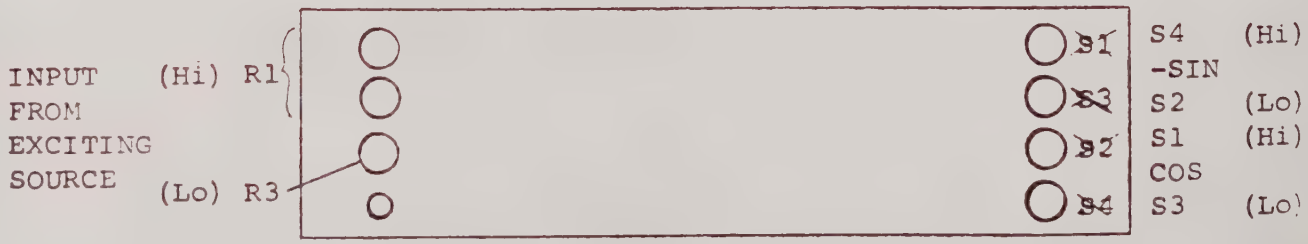
ALTERNATE RESOLVER SIMULATOR CONVENTIONS
(ALL ASSUME CCW IS POSITIVE ROTATION)



MODEL 530 SIMULATOR
RESOLVER MODE
FIG 4.6a

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Resolver Bridge

The input and output terminals of the North Atlantic Series 540 and 541 Resolver Bridge are analgous to those of a stator excited resolver Control Transformer (RC). The connections which correspond to those shown in the diagram of 4.5 are illustrated for a Model 540 Bridge in Figure 4.7.

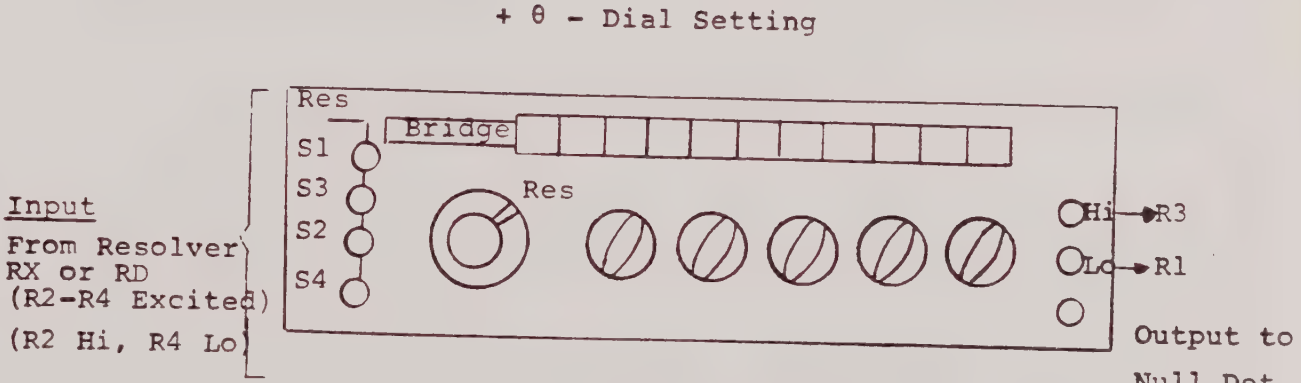
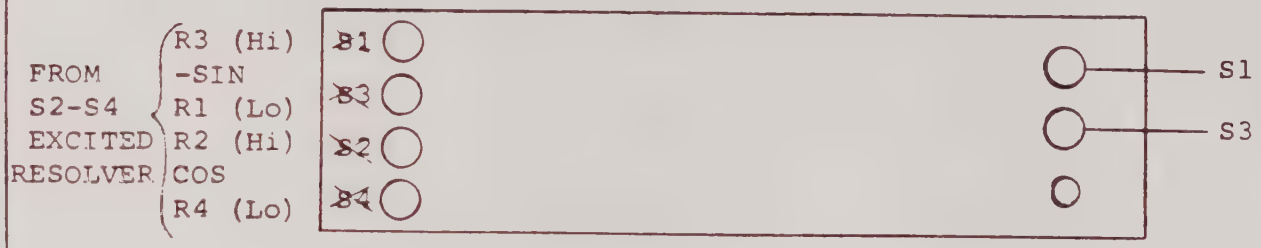


Figure 4.7 - Model 540 Bridge
(Resolver Mode)

ALTERNATE RESOLVER BRIDGE CONVENTIONS
(ALL ASSUME CCW IS POSITIVE ROTATION)



MODEL 540 BRIDGE
RESOLVER MODE
FIG 4.7a

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SECTION V

THEORY OF OPERATION

North Atlantic Resolver and Synchro Simulators basically consist of three transformer sections. The first, or Input Section, , utilizes a tapped transformer which can be switched to provide the various line to line output voltage levels. The second section, called the Trigonometric Divider Section, produces two outputs precisely proportional to the sine and cosine of the angle selected by a series of front panel switches. The third section is a Form Converter Section which produces on the output terminals isolated synchro (3 wire) or resolver (4 wire) data at very low impedance levels.

The Model 530 Resolver-Synchro Simulator, which has all of the Transformer Sections described above, can be understood by referring to Figure 5.1.

The exciting signal 115V or 26V is applied to a tapped auto-transformer from which the desired line to line output level can be selected via Switch SA.

The output of the input voltage selection circuit is used to excite a pair of trigonometric divider sets. Each divider set produces a ratio equivalent to the sine or cosine of the angle set into the Simulator by the front panel knobs.

Each divider consists of a series of precision tapped toroidal transformers arranged in a novel circuit (patents applied for) which facilitates the precise interpolation of the angular data.

The outputs of these independent divider chains are applied in turn to the Form Converter which is comprised of several

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precisely matched toroidal transformers. The Form Converter presents as an output either 3-wire synchro data or 4-wire resolver data depending upon the circuit arrangement selected by the Mode Selector Switch SB.

Both Resolver and Synchro modes provide outputs which are isolated from the input excitation.

It is important to realize that the open circuit data output from the Simulator is defined in terms of the ratio of the output signals. For the Resolver Mode, the two outputs are:

$$E_{S1-S3} = K_1 \text{ Sin } \theta$$

$$E_{S2-S4} = K_2 \text{ Cos } \theta$$

Since $K_1 = K_2$ to an accuracy of 1 or 2ppm then:

$$\frac{E_{S1-S3}}{E_{S2-S4}} = \text{Tan } \theta$$

Thus, the output ratio defines the tangent of the selected input data angle to the accuracy specified for the instrument.

In similar fashion, the data angle is defined for an ideal synchro in terms of the ratio of any two of the three output voltages:

$$E_{S1-S3} = K_1 \text{ Sin } \theta$$

$$E_{S3-S2} = K_2 \text{ Sin } (\theta + 120^\circ)$$

$$E_{S2-S1} = K_3 \text{ Sin } (\theta + 240^\circ)$$

Again, since $K_1 = K_2 = K_3$ to an accuracy of 1 or 2ppm, the ratio of any two will define the angle in accordance, for

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example, with the expression:

$$\frac{E_{S1-S3}}{E_{S2-S1}} \qquad \frac{\text{Sin } \theta}{\text{Sin } (\theta + 240°)}$$

Note that since any two of the three synchro voltages will determine the third by Kirchoff's Law, there are, therefore, two other redundant equations relating the data angle θ, to voltage ratios.

An important aspect of any Simulator is the effect of a load on the accuracy of the ratios just described. All North Atlantic Simulators have low nominal output impedances which minimize the effect of a load on the Simulator. Further, the design provides for a careful match of output impedance such that the effect of a load impedance is even further reduced, being related to the impedance unbalance rather than the absolute level.

The actual relationship of impedance unbalance and load is quite complex and is a function not only of the unbalance impedance, but also the data angle itself. This is apparent if it is noted that an unbalance impedance would not be equally important for all ratios. For example, in the limiting case of an angle defined by a ratio of zero, neither load impedance or unbalance impedance could change the ratio.

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Switching

All North Atlantic Simulators contain inductive transformer sets which perform a basic 10° interpolation followed by succeeding decades of interpolation for 5° (in case of 5° models only), 1°, 0.1°, .01°, and .001°.

The first or 10° switch is a unique design, original in North Atlantic equipment, which links the 10° knob to both a 350° total display range and a 90° quadrant switch (not displayed). By using this technique, an in-line, non-ambiguous display of 0° to 350° in 10° increments with a direct return to zero is possible with no direction reversal and no need to mentally add dial readings.

All switches are designed with heavy-duty silver alloy buttons for long life and have transient suppression resistors mounted directly on the switch decks.

On 5°, one knob models, a special escapement mechanism is used to link a basic 10° switch (internal) to this knob which has alternate positions of 0° to 5°. Thus, whenever the position of the single knob is advanced from a 5° to 0° position or vis versa, the 10° switch is advanced or stepped back in synchronism. This arrangement is inherently self-synchronizing and cannot result in a false reading.

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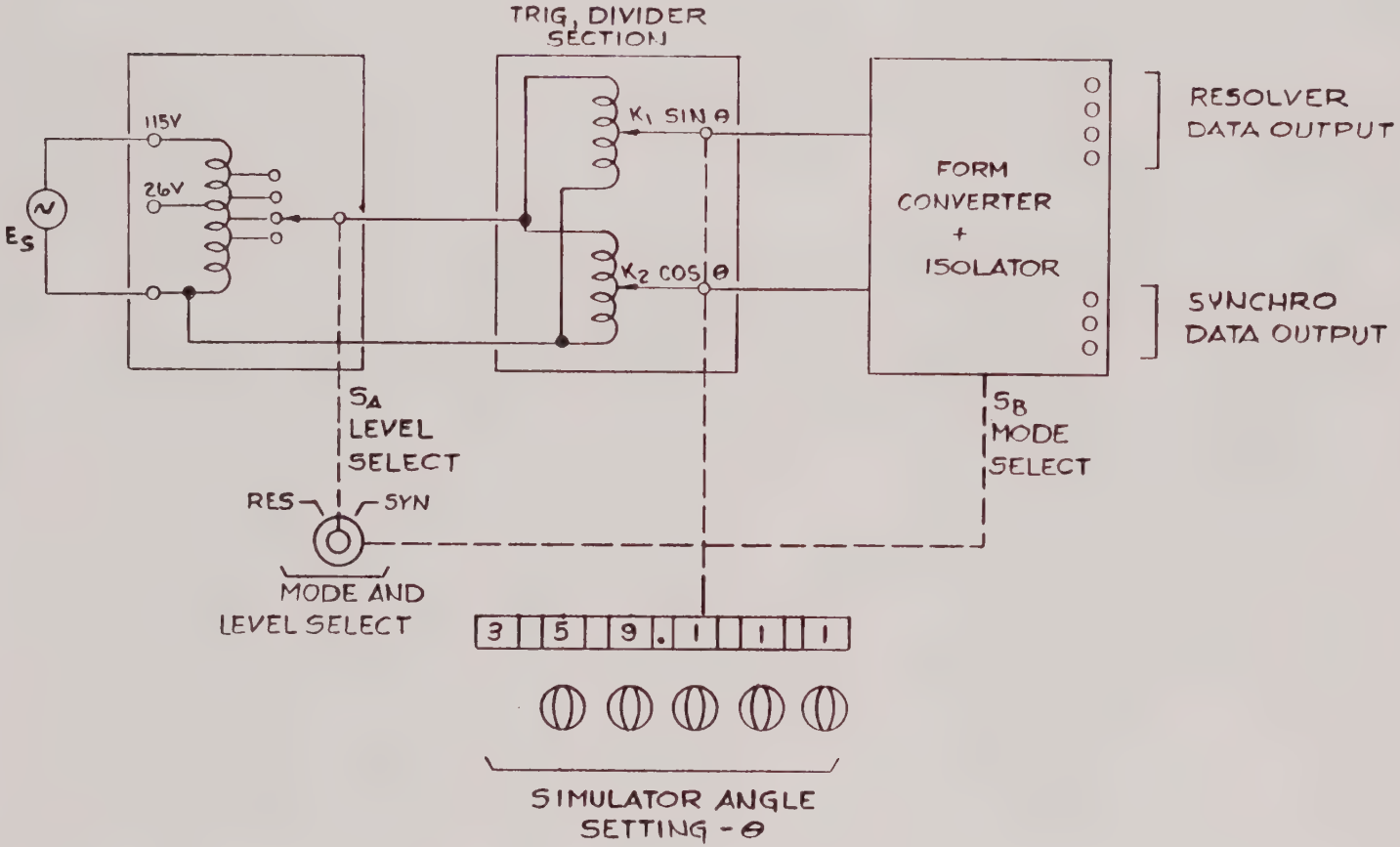

Figure 5.1

BLOCK SCHEMATIC OF MODEL 530
RESOLVER/SYNCHRO SIMULATOR

SECTION VI

MAINTENANCE

The North Atlantic Series 530 Resolver-Synchro Simulators contain highly accurate inductive circuits. Under normal operating conditions, the accuracy of these devices should remain within specified tolerances indefinitely. It should be noted, however, that the application of DC to the circuits in the 530 could result in a degradation of the operating characteristics.

Degaussing

If DC has been applied to any of the terminals in the 530, it may be degaussed by attaching the circuit shown in 6.1 to all input terminal pairs in sequence. For dual-mode degaussing, the three synchro inputs will cover both modes.

With all knobs set at zero, apply the 30Hz voltage to the instrument by slowly raising it from zero to the point at which saturation occurs.

This will be evidenced when further increase in the setting of the Variac results in a relatively small increase in the voltage applied across the instrument. Allow the instrument to remain under the saturated conditions for a short period (typically 5 to 10 minutes). Then, slowly reduce the voltage to zero. Any residual magnetism stored in the core by the DC should now be removed and the instrument should function properly. If it still does not operate within the specified tolerance, return it to the factory.

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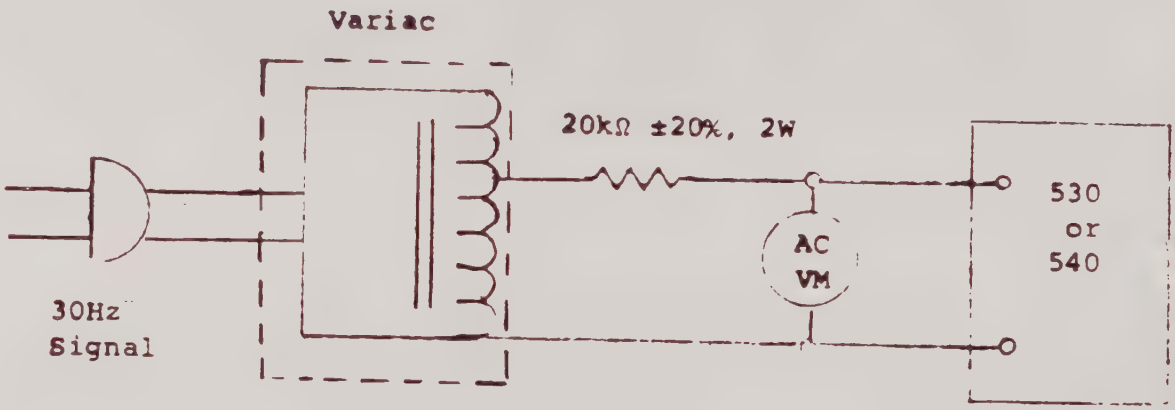


Figure 6.1

DEGAUSSING CIRCUIT

Switches

All switches used for switching critical inductive circuits are designed for long life using heavy duty alloy button contacts.

For normal maintenance, switch contacts should be cleaned with a good grade solvent, such as alcohol, and relubricated with a very thin film of clean switch lubricant, such as petroleum jelly, every 4 to 6 months of use.

If an instrument has not been used for an extended period of time, it may be desirable to cycle switches several times so as to wipe contacts clean prior to making measurement. This routine can be considered normal for an instrument of this type.

Should a precision switch need to be replaced, remove all wire connections by carefully sliding female Malco type wire connectors away from switch deck. This is readily accomplished by using a pair of long-nose pliers.

CAUTION: Do not unnecessarily remove Malco terminals since excessive disassembly may impair self-clinching characteristic of the connector.

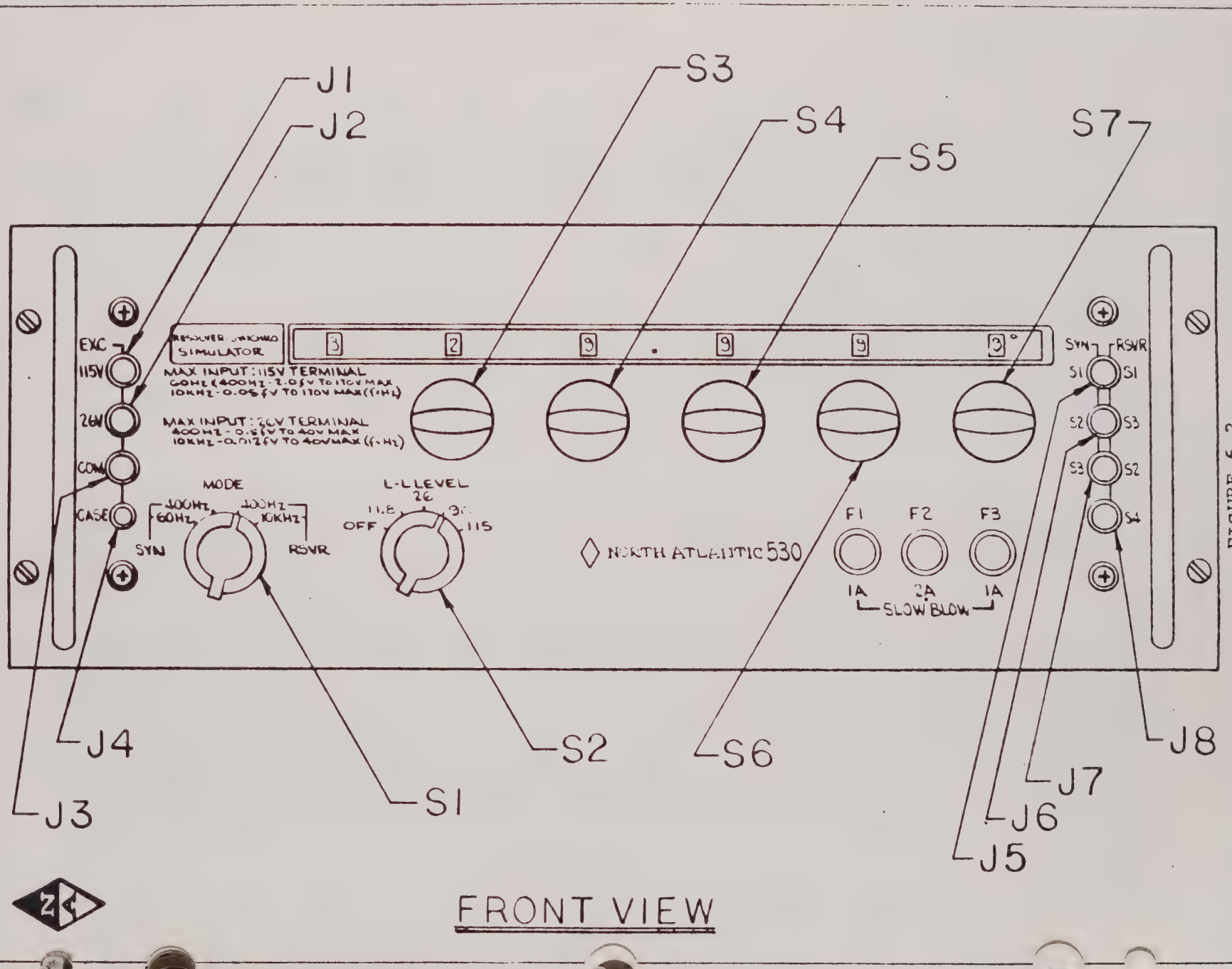
Transformers

If a malfunction occurs which indicates that a transformer component is faulty, return the unit to the factory for overhaul and recalibration.

Calibration

Routine recalibration of a North Atlantic Simulator is normally not required except insofar as the customer quality assurance methods require these checks so as to be certain that

no random failures have caused the instrument to malfunction. Should recalibration be required, follow the procedure outlined in Section VII.



FRONT VIEW

FIGURE 6.2

5/24/68

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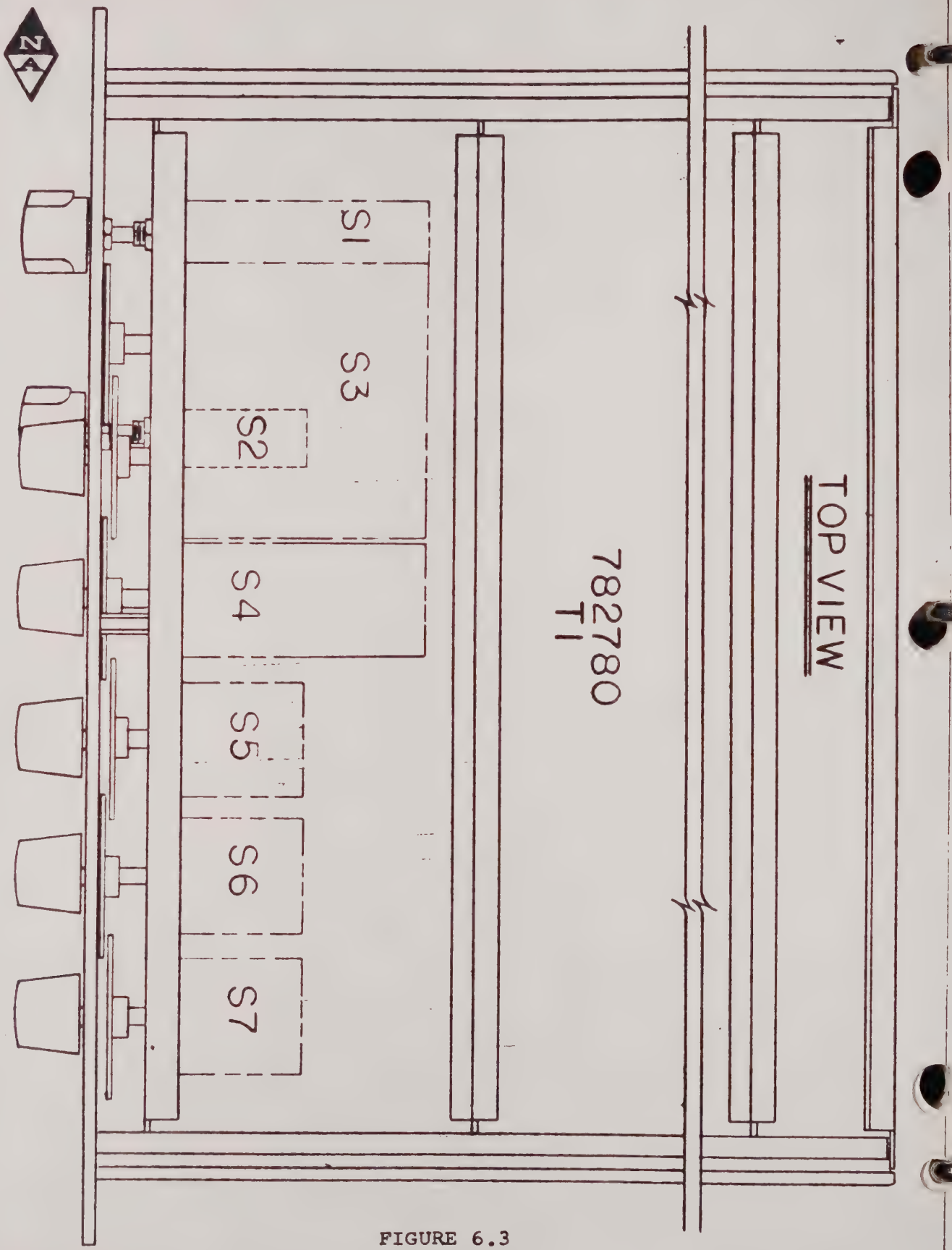

FIGURE 6.3

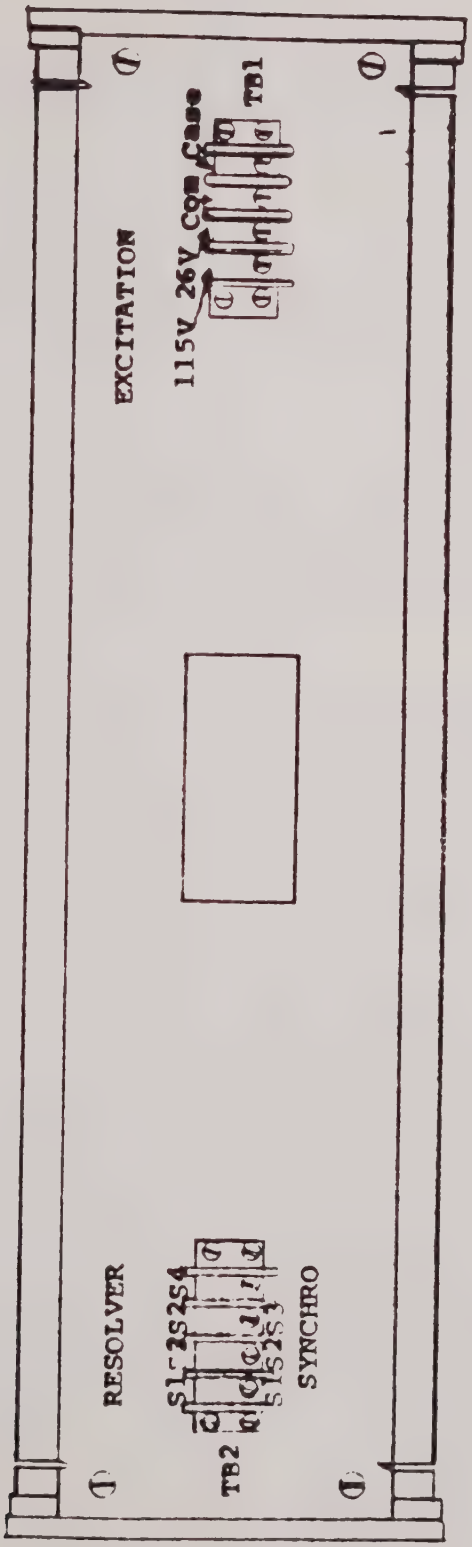

FIGURE 6.4

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SECTION VII

CALIBRATION PROCEDURES FOR RESOLVER/SYNCHRO BRIDGES AND SIMULATORS

General

The philosophy governing the calibration of a Resolver/Synchro Inductive Simulator or Bridge and the establishing of meaningful standards involves consideration similar to those encountered in the area of AC Ratio Boxes.

In both cases, calibration data is a matter of ratio accuracy. For the Ratio Box, it is the ratio of the output to the input. For the Resolver Bridge or Simulator, it is the ratio of two AC voltages, while for a Synchro Bridge or Simulator, it is the ratio of any two of the three line-to-line voltages.

Thus, ratio is the all important measurement and herein lies the need for an appreciation of the difference between Ratio Certainty and a standard as defined by the Bureau of Standards. AC Ratio is not uniquely related to, or logically measurable in terms of, the usual physical concepts of mass, length, or time since it is a dimensionless quotient. As such, it is not traceable to any absolute electrical standard such as the ohm, volt, or ampere.

AC Ratio, by its nature, can be known to an almost unlimited degree of precision depending upon the ingenuity of the person making the measurement and the stability of the equipment used. Typically, in the area of AC Ratio measurements, measurements have been made at the National Bureau of Standards as well as in industry to precision in order of 0.01ppm and better. Yet, at this time, no known set of circuit elements could be assembled into a single instrument which would provide a certainty of measurement of this order of magnitude for a reasonable range of voltages, temperature, frequency, ratio, or time. This, in effect, represents the present state of the art in AC ratio measurements.

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Since the "technique" of AC ratio measurement is considerably better than any commercially available ratio reference, it must be readily apparent that an Inductive Ratio Box, rated at 1.0 ppm accuracy, can be evaluated or calibrated so as to provide confidence in this rating over a reasonable period of time and under the rated conditions of voltage, frequency, temperature, and ratio range. The National Bureau of Standards provides such a calibration service and evidences their calibration in the form of a record of calibration as of the time the ratios were measured. It remains for the user and manufacturer to determine the period over which confidence in this rating can be maintained.

It is the experience of North Atlantic, over a period of many years, that a properly maintained Inductive Ratio device such as a Ratio Box, Bridge, or Simulator, will sustain its ratio accuracy to a confidence level of well under 1.0 ppm for a period of many years.

Simulator and Bridge Calibration

In the procedure to follow, a technique for calibrating both Resolver/Synchro Simulators and Bridges is presented which follows the philosophy just described. Through use of a Ratio Reference such as a 1.0 ppm, North Atlantic RB-504 Ratio Box, it is merely a matter of technique by which both Bridges and Simulators can be calibrated to a level of confidence comparable to the Ratio Reference itself. Noting that an uncertainty in ratio, equivalent to ±1.0 ppm (against unity ratio) is, in the worse case, equivalent to an angular uncertainty of only ±0.2 arc second, it is apparent that a high degree of confidence can be expected in the ultimate calibration data for Resolver and Synchro Bridges and Simulators.

It should be noted that the 1.0 ppm terminal linearity rating of the RB-504 Ratio Box is certifiable by North Atlantic against a factory standard which in turn, has a record of calibration issued by the National Bureau of Standards.

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Calibration Period and Method

The frequency of calibration required for Resolver/Synchro Bridges and Simulators is necessarily dictated by the application and the established policies of the user. Since the construction of all North Atlantic Bridges and Simulators uses heavy-duty switches and quality torroidal transformers, it is recommended that full calibration (calibration Procedure II) will only infrequently be required. However, where Quality Control procedures require routine checks to make certain that no random equipment failures have occurred, the simpler Calibration Procedure I may be used.

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CALIBRATION PROCEDURE I

General

This procedure can be used to calibrate on a GO-NO-GO basis either a Bridge or a Simulator. The validity for this type of comparison can be taken as the sum of the rated Bridge error and the rated Simulator error or ±30 arc seconds.* The procedure is recommended as a routine Quality Control Calibration to verify proper operation of the equipment.

Equipment Required

One - Reference Bridge or Simulator

Typical Resolver-Synchro Bridge Model 540 S-1486
5 knob, .001° resolution or typical
Resolver-Synchro Simulator Model 530 S-1487
5 knob, .001° resolution.

One - Phase Angle Voltmeter

Model 214C Operative at the appropriate frequency (60, 400, and 10KHz)

One - Adjustable Source of 60, 400, and 10KHz

Procedure

Connect equipment as shown in Figure 7.1 and proceed as follows:

A. Using appropriate Reference Simulator or Bridge, adjust all knobs to read zero on both the test item and the reference equipment.

* ± 40 Arc Seconds at 10K Hz

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B. Adjust supply to 26V or 115V at appropriate frequency depending upon Simulator input terminal used.

C. Adjust the Phase Angle Voltmeter to read an in-phase null (see Operating Instructions in this manual, Section III).

D. Offset either the simulator or Bridge by 0.02° or 72 seconds. Select convenient meter range where vernier will permit adjustment of reading to 72 on X10 scale. Meter is now appropriately scaled to measure the deviation between the Bridge and Simulator directly in seconds by ranging to any convenient scale.

E. Track both Simulator and Bridge through desired calibration angles, noting that readings all fall within ±30 arc seconds.*

If in Step E above, readings fall outside the ± 30 second* spread, recheck operation of the Phase Angle Voltmeter and test circuit to be certain the hookup is correct and that no ground loops, unground terminals, etc., exist. If the out of tolerance reading is reaffirmed, proceed to the more elaborate Calibration Procedures II.

* ± 40 Arc Seconds at 10K Hz.

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CALIBRATION PROCEDURES II

General

The Calibration Procedure II is designed to provide what might be thought of as an "ideal" calibration. In the case of a Bridge, means are taken to eliminate any errors due to loading of the source impedances by the Bridge. In the case of the Simulator, the calibration method closely approximates the conditions of a Simulator driving a high impedance load, thereby providing an "ideal" open-circuit accuracy.

The procedure is arranged in two parts. The first covers the calibration of a Resolver Bridge and a Synchro Bridge to a ratio measurement validity of approximately ±1.0 ppm or the equivalent of a ±0.2 arc seconds.

The second part of this procedure makes use of a Bridge calibrated in accordance with the above. The Bridge is then used as a calibrated transfer reference against which a Resolver or Synchro Simulator can be calibrated. This procedure results in a validity of calibration of approximately ±0.4 arc seconds for a Simulator.

A word of caution should be made regarding the use of alternate methods of calibration such as those using a resistance Bridge or methods utilizing single Ratio Box techniques. Although good results may be obtainable, insidious errors due to impedance loading,

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phase shift, etc., are easily overlooked. The procedures described are recommended principally because the simplicity of the setup does not need a particularly high degree of "ingenuity" or experience to achieve the accuracy sought.

Resolver Bridge Calibration

The following procedure can be used to calibrate the Model 540 Multi-frequency Bridge, such as S-1486, S1635.

A. Equipment Required for 400Hz

Two - Ratio Boxes, North Atlantic Model RB512 or 503.

One - 1.0ppm Ratio Box, North Atlantic Model RB504.

One - Shielded Bridge - Null Transformer, North Atlantic Model T110.

Two - Phase Angle Voltmeter, Model 214C with high sensitivity (300μV).

One - Adjustable Source of 400~ AC Voltage.

Two - DPDT Switches.

B. Equipment Required for 10KHz

Three - Ratio Boxes Model RB512 or 503.

One - 10KHz Bridging Transformer

One - T110 Bridging Transformer

One - Phase Angle Voltmeter, Model 214C with 60Hz, 400Hz, 10KHz capability.

Two - DPDT Switches

One - Adjustable Source of 10KHz AC Voltage

Procedure

Connect the equipment as shown in Figure 7.2 for 400Hz and 7.4 for 10KHz. Note that in this arrangement, Ratio

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Boxes RB-1 and RB-2 will serve to generate resolver voltages suitable for driving the inputs of the Bridge being calibrated. Since these boxes have finite output impedances which vary with ratio settings, some loading errors can be expected due to the input impedance of the Bridge being tested.

To correct for this loading error, the 1.0ppm RB-504 designated RB-S is used as a precision ratio transfer device. Ratios can be set up on RB1 and RB2 while under load. The Bridge Null Transformer and Phase Angle Voltmeter - No.1, are used to make the comparison between the Ratio Reference, RB-S, and the driving Ratio Boxes, RB1 and RB2. Note for 10KHz RB-T must be set for first three places of RB-S.

Proceed as Follows:

A. Adjust Variac T-1 or variable source for desired line-to-line voltage (90, 11.8, etc.) to accuracy of ±5%.

B. Adjust Phase Angle Voltmeter - No. 1 for making an in-phase null (0°).

C. With Resolver Bridge under test set at the angle being calibrated, set RB-S to desired sine (RB-2) ratio, using values from Tables I, II, III, and IV.

D. Connect Null Transformer lead "A" to the output of the Box RB-2 and adjust for null on the Phase Angle Voltmeter - No. 1. Set to resolution of at least 1/3ppm.

E. Repeat Steps C and D for setting of Box RB-1.

F. Input to Bridges is now accurate to within ±.2 sec. Now adjust Bridge to achieve in-phase null on Phase Angle Voltmeter - No.2. Calibration angle is read from Bridge and recorded.

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G. Repeat Steps C through F for each angle to be calibrated. Note that Tables I through IV are given for the most commonly tested angles.

Synchro Bridge Calibration

A. Equipment Required for 400Hz

Two - Ratio Boxes, North Atlantic Model RB512 or 503.

One - 1.0ppm Ratio Box, North Atlantic Model RB504

One - Shielded Bridge Null Transformer, North Atlantic Model T110.

Two - Phase Angle Voltmeter, North Atlantic Model 214C with high sensitivity (300μV).

Three - SPTT Switches

One - Adjustable Source of AC Voltage

B. Equipment Required for 60Hz

Two - 60Hz Ratio Boxes, North Atlantic Model 512.

One - 60Hz Standard (Gertsch RT1004 or equiv).

One - T110 Bridging Transformer*

One - Phase Angle Voltmeter, Model 214C with 60Hz 400Hz, and 10KHz capability.

Three - SPTT Switches

One - Adjustable AC Voltage source.

*Note: Always disconnect T110 when operating at 60Hz until the ratios are set to approximately the right values. This is necessary because the T110 will saturate at 40V at 60Hz.

Procedure

Connect the equipment as shown in Figure 7.3. Note that in this arrangement Ratio Boxes RB-1 and RB-2 will serve to generate synchro input voltages suitable for driving the inputs of the Bridge being calibrated. Since these Boxes have finite output impedances which vary with ratio settings, some loading errors can be expected due to the input impedance of the Bridge being tested.

ERROR UNCERTAINTY

Freq.	Ratio Box Std.	T110 CM	Set-up (coupling etc)	Total	Error in Sec
400 Hz	(504) ± 1 ppm	.5 ppm	1 ppm	3.5 ppm	.35
60 Hz	(1004) ± 1 ppm	.5 ppm	1 ppm	3.5 ppm	.35
10K Hz	(23) ± 3 ppm	5 ppm	5 ppm	16 ppm	1.6

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To correct for this leading error, the 1.0ppm RB-504 designated RB-S is used as a precision ratio transfer device by which the proper voltage ratios can be set up on RB-1 and RB-2 while under load. The Bridge Null Transformer and Phase Angle Voltmeter No.1, are used to make the comparison between the Ratio Reference RB-S and the driving Ratio Boxes RB-1 and RB-2.

Proceed as Follows:

A. Adjust Variac T-1, or variable source for desired line-to-line voltage (90, 11.8, etc.) to accuracy of ±5%.

B. Adjust Phase Angle Voltmeter - No. 1, for making an in-phase null (0°).

C. With Synchro Bridge under test set at the angle being calibrated, set RB-S to desired setting of RB-2 obtained from Tables V, VI, VII, and VIII.

D. Connect Null Transformer lead A to the output of Box RB-2 and adjust same for null on Phase Angle Voltmeter - No. 1, set to resolution of at least 1/3 ppm.

E. Repeat Steps C and D for setting on RB-1.

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F. Input to Bredge is now accurate to within ±.2 seconds. Now adjust Bridge to achieve in-phase null on Phase Angle Voltmeter - No. 2. Calibration angle is read from Bridge and recorded.

G. Repeat 3 through 6 for each angle to be calibrated. Note that Table V through VIII are given for the most commonly tested angles.

Semiconductor Calibration

Equipment Required

One - Phase Angle Voltmeter, North Atlantic Model 214C with high sensitivity, (300μV) and range vernier option.

One - Calibrated Bridge, type to cover mode of operation desired, North Atlantic Model 540, 5 knob, .0001° resolution. (S1486).

One- Adjustable AC Voltage Source.

Procedure

Connect equipment as shown in Figure 7.1. The technique used in calibrating a Simulator consists in comparing the Simulator under test to a Bridge calibrated in accordance with the methods previously outlined.

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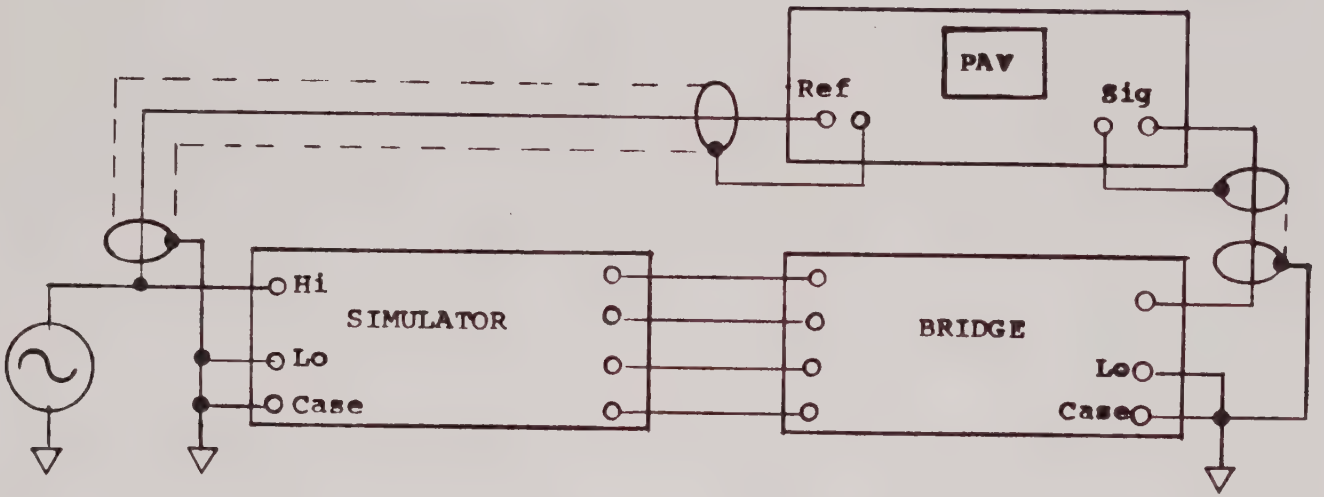

FIGURE 7.1 - CALIBRATION CIRCUIT

Calibration I: Bridge or Simulator

Calibration II: Simulator only

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The technique is identical to that for a Calibration Procedure I. Comparison can be made by the deviation method described under Calibration Procedure I or by nulling using either the calibrated Bridge or the Simulator under test. The calibration error, of course, would be the combination of the calibration data for Bridge plus the deviation of the Bridge and Simulator as measured in this test.

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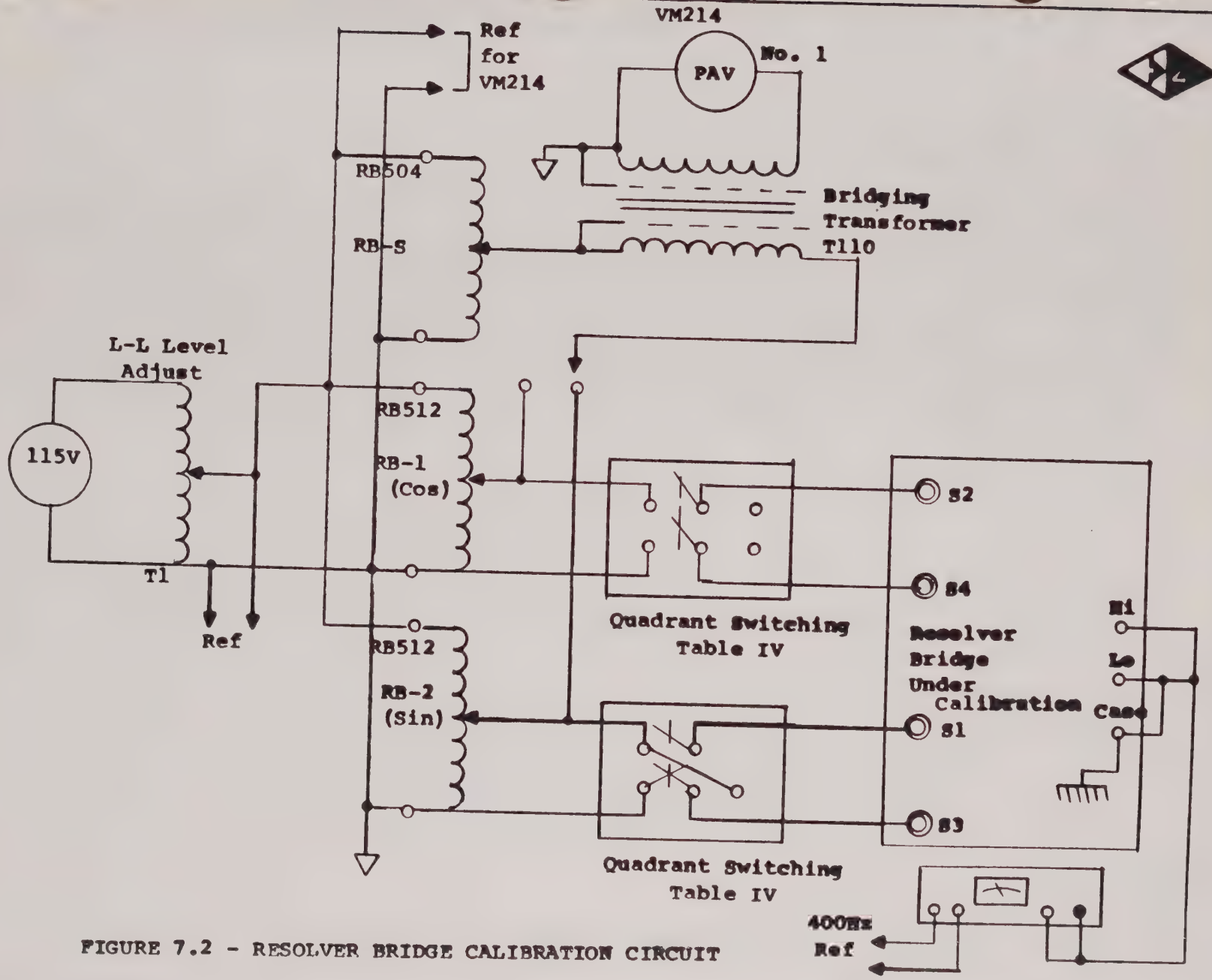

FIGURE 7.2 - RESOLVER BRIDGE CALIBRATION CIRCUIT

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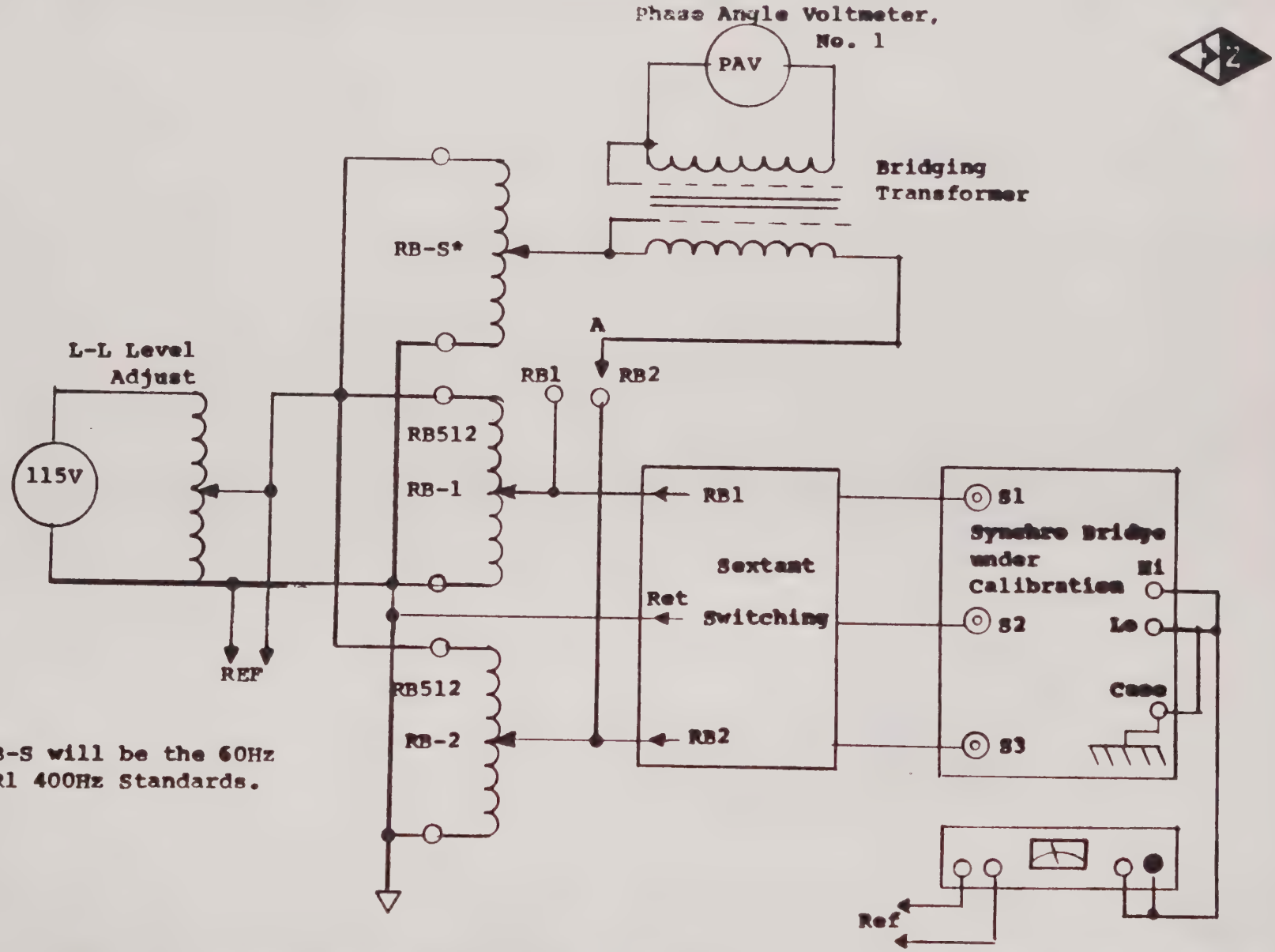

FIGURE 7.3 - SYNCHRO BRIDGE CALIBRATION CIRCUIT
(60Hz and 400Hz)

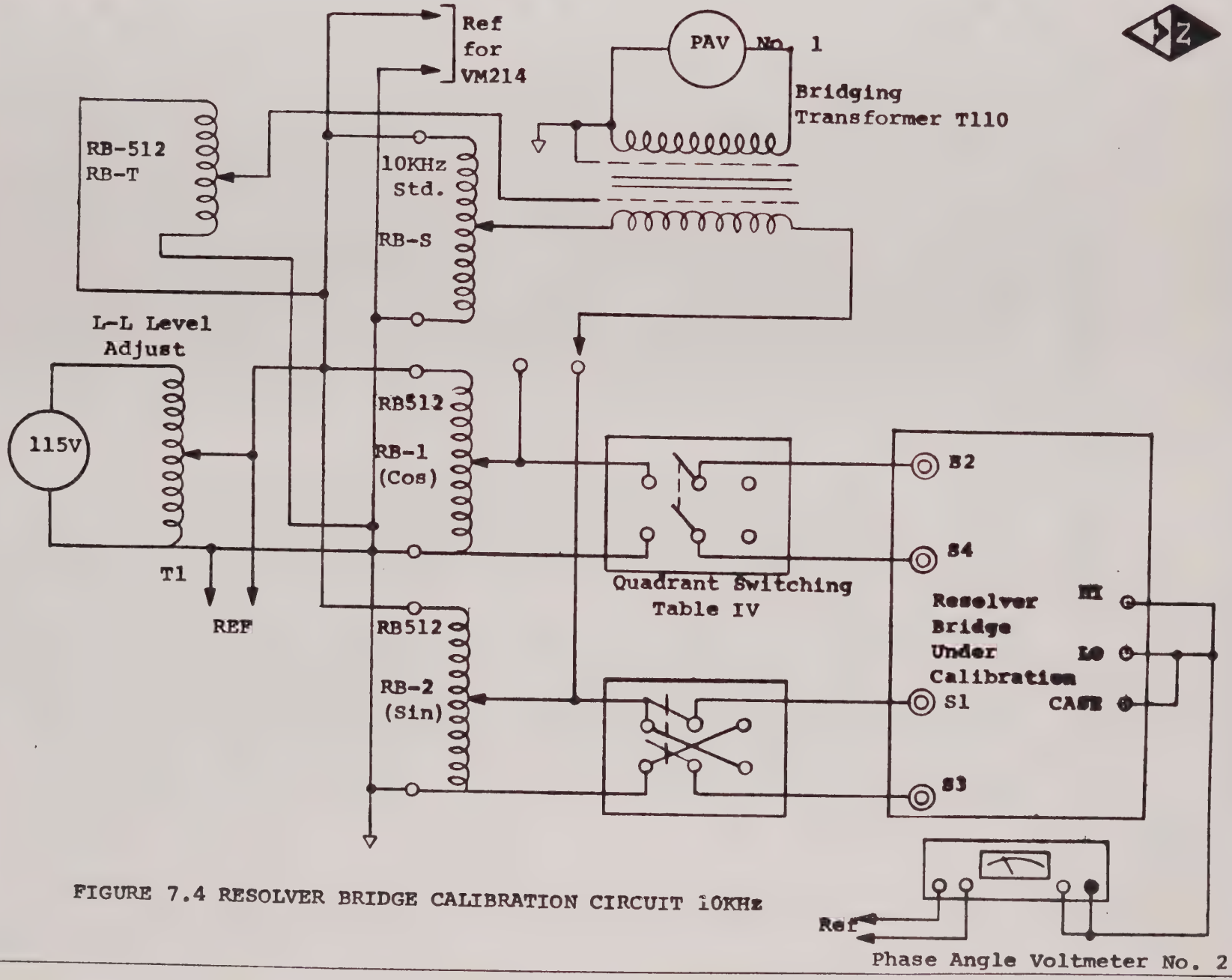

FIGURE 7.4 RESOLVER BRIDGE CALIBRATION CIRCUIT 10KHz

TABLE I

RESOLVER CALIBRATION CHART

I	II	III	IV	RR1	RR2
0	180	180	360	1.0000000	.0000000
5	175	185	355	.9961946	.0871557
10	170	190	350	.9848077	.1736480
15	165	195	345	.9659258	.2588190
20	160	200	340	.9396926	.3420201
25	155	205	335	.9063077	.4226182
30	150	210	330	.8660254	.5000000
35	145	215	325	.8191520	.5735764
40	140	220	320	.7660444	.6427876
45	135	225	315	.7071067	.7071067
50	130	230	310	.6427876	.7660444
55	125	235	305	.5735764	.8191520
60	120	240	300	.5000000	.8660254
65	115	245	295	.4226182	.9063077
70	110	250	290	.3420201	.9396926
75	105	255	285	.2588190	.9659258
80	100	260	280	.1736480	.9848077
85	95	265	275	.0871557	.9961946
90	90	270	270	.0000000	1.0000000

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TABLE II

RESOLVER CALIBRATION CHART

	RB1 (Cos)	RB2 (Sin)
40.000	.7660444	.6427876
41.000	.7547096	.6560590
42.000	.7431448	.6691306
43.000	.7313537	.6819984
44.000	.7193398	.6946584
45.000	.7071068	.7071068
46.000	.6946584	.7193398
47.000	.6819984	.7313537
48.000	.6691306	.7431448
49.000	.6560590	.7547096
40.1	.7649214	.6441236
40.2	.7637960	.6454577
40.3	.7626683	.6467898
40.4	.7615383	.6481199
40.5	.7604060	.6494480
40.6	.7592713	.6507742
40.7	.7581343	.6520984
40.8	.7569951	.6534206
40.9	.7558535	.6547408

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TABLE III

RESOLVER CALIBRATION CHART

Angle	RB1 (Cos)	RB2 (Sin)
40.01	.7659322	.6429213
40.02	.7658200	.6430550
40.03	.7657078	.6431886
40.04	.7655955	.6433223
40.05	.7654832	.6434559
40.06	.7653709	.6435895
40.07	.7652586	.6437230
40.08	.7651461	.6438566
40.09	.7650338	.6439901
40.001	.7660332	.6428010
40.002	.7660220	.6428143
40.003	.7660107	.6428277
40.004	.7659995	.6428411
40.005	.7659883	.6428545
40.006	.7659771	.6428678
40.007	.7659659	.6428812
40.008	.7659546	.6428946
40.009	.7659434	.6429073

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TABLE IV

RESOLVER CALIBRATION

QUADRANT SWITCHING TABLE

Quadrant	Angle	Hi	Lo	Hi	Lo
I	0-90	S2	S4	S3	S1
II	90-180	S4	S2	S3	S1
III	180-270	S4	S2	S1	S3
IV	270-360	S2	S4	S1	S3

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TABLE V

SYNCHRO CALIBRATION CHART

I	II	III	IV	V	VI	RB1	RB2
0°	120°	120°	240°	240°	360°	.8660254	.000000
5°	115°	125°	235°	245°	355°	.9063077	.0871557
10°	110°	130°	230°	250°	350°	.9396926	.1736480
15°	105°	135°	225°	255°	345°	.9659258	.2588190
20°	100°	140°	220°	260°	340°	.9848077	.3420201
25°	95°	145°	215°	265°	335°	.9961946	.4226182
30°	90°	150°	210°	270°	330°	1.0000000	.5000000
35°	85°	155°	205°	275°	325°	.9961946	.5735764
40°	80°	160°	200°	280°	320°	.9848077	.6427876
45°	75°	165°	195°	285°	315°	.9659258	.7071067
50°	70°	170°	190°	290°	310°	.9396926	.766044
55°	65°	175°	185°	295°	305°	.9063077	.8191520
60°	60°	180°	180°	300°	300°	.8660254	.8660254

Rev A: 12/1/65
Rev B: 3/23/66

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TABLE VI

SYNCHRO CALIBRATION CHART

Angle	RB1 (Cos)	RB2 (Sin)
40	.9848077	.6427876
41	.9816272	.6560590
42	.9781476	.6691306
43	.9743701	.6819984
44	.9702957	.6946584
45	.9659258	.7071067
46	.9612617	.7193398
47	.9563048	.7313537
48	.9510565	.7431448
49	.9455186	.7547096
40.1	.9845032	.6441236
40.2	.9841956	.6454577
40.3	.9838850	.6467898
40.4	.9835715	.6481199
40.5	.9832549	.6494480
40.6	.9829353	.6507742
40.7	.9826128	.6520984
40.8	.9822873	.6534206
40.9	.9819587	.6547408

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TABLE VII

SYNCHRO CALIBRATION CHART

Angle	RB1 (Cos)	RB2 (Sin)
40.01	.9847774	.6429213
40.02	.9847471	.6430550
40.03	.9847167	.6431886
40.04	.9846863	.6433223
40.05	.9846558	.6434559
40.06	.9846254	.6435895
40.07	.9845949	.6437230
40.08	.9845643	.6438566
40.09	.9845338	.6439901
40.001	.9848047	.6428010
40.002	.8848016	.6428143
40.003	.9847986	.6428277
40.004	.9847956	.6428411
40.005	.9847926	.6428545
40.006	.9847895	.6428678
40.007	.9847865	.6428812
40.008	.9847835	.6428946
40.009	.9847804	.6429073

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TABLE VIII

SYNCHRO CALIBRATION

SEXTANT SWITCHING CHART

		RB1		RB2
Sextant	Angle	Hi	Ret	Hi
I	0-60	S2	S1	S3
II	60-120	S3	S1	S2
III	120-180	S3	S2	S1
IV	180-240	S1	S2	S3
V	240-300	S1	S3	S2
VI	300-360	S2	S3	S1

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SECTION VIII

ROTARY COMPONENT MEASUREMENT

The following is a detailed step-by-step procedure for precise test of the most commonly encountered types of synchros and resolvers.

I. Synchro Transmitter (CX) Test

A. Phasing, Electrical Zero, and Angular Accuracy

1. Connect CX, 540, and PAV as shown in schematic. Rotate CX shaft conterclockwise as viewed from shaft end until PAV reads zero. Note that the meter approaches 0 from left to right. For 115V excitation, use 100V range of the voltmeter.

2. With synchro shaft at the null point, switch 540 to 5°. The voltmeter should deflect to the left. Set 540 back to 0.

3. If the requirements of Steps 1 and 2 are met, the phase is correct, and the null point is electrical zero.

4. Mount CX in a dividing head.

5. With the dividing head at 0, CX must be at electrical zero, as described in Steps 1 and 2.

6. Set voltmeter Function Selector to 90°.

7. Set 540 to 90°.

8. Rotate Phase Dial on the Voltmeter until a quadrature null is reached.

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9. The angle read on the Phase Angle Dial is approximately equal to the phase shift of the CX.

10. With the Phase Dial at this setting, return 540 and the Function Selector to 0°.

11. Re-zero CX in dividing head if necessary.

12. With the CX at 0, offset the dividing head an amount equal to the maximum allowable error of the CX.

13. Down scale the Range Selector until the first off-scale meter reading is reached. Turn the Range Selector to the next up-scale range. Record the deflection on the PAV. This is the maximum allowable error voltage.

14. Return the dividing head to 0°.

15. Advance the 540 and the dividing head in the required increments. The null error, as noted on the PAV, should be less than that obtained in Step. 13.

B. Null Test, "Total" and "Fundamental"

1. With the CX still mounted in the dividing head, set up circuit indicated.

2. Rotate the dividing head to 120°.

3. Set the voltmeter Function Selector to 0°, and adjust the dividing head for a null.

4. Read the nulls in both Total and Fundamental.

5. Attach PAV leads to S2 and S3, and rotate the dividing head to 240°.

6. Repeat Steps 3 and 4

7. Attach PAV leads to S1 and S3, and rotate the dividing head to 0°.

8. Repeat Steps 3 and 4.

C. Transformation Ratio Test

1. Turn Phase Angle Dial to 0°.

2. With the CX still mounted in a dividing head, set up the circuit indicated.

3. Set Function Selector to 0°.

4. Set the dividing head to 30°, and adjust Ratio Box for a null. Record ratio reading (transformation ratio).

D. Phase Shift Test

1. With the CX still mounted in the dividing head, set up circuit indicated.

2. Switch voltmeter Function Selector to 90° position.

3. With dividing head at 30°, adjust the Phase Angle Dial on the voltmeter for a quadrature null.

4. The phase shift of the CX may be read directly from the Phase Angle Dial.

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E. Input Current Test

1. Set up circuit indicated.

2. Turn voltmeter Function Selector to the Total position.

3. The input current of the CX is read directly in amperes on the voltmeter, i.e., .1 volt = .1 amperes.

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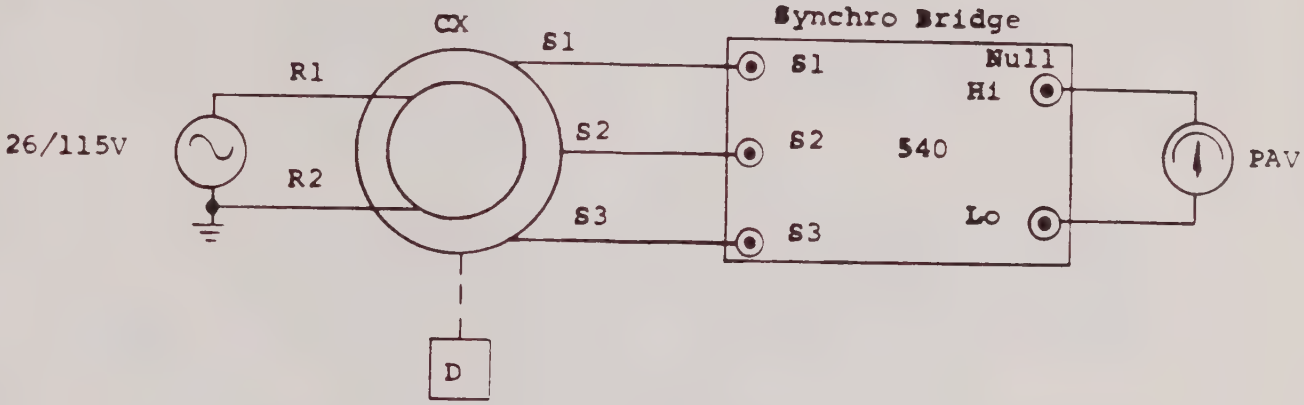
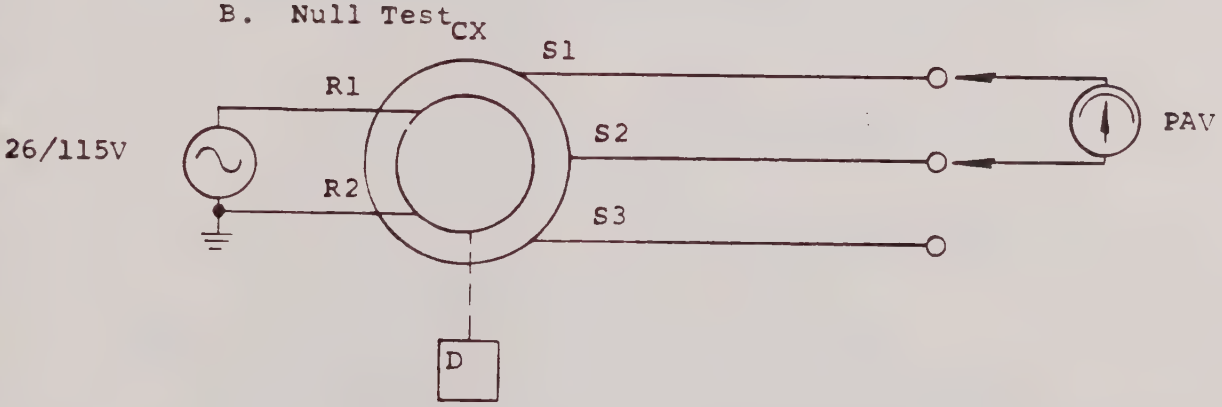
TEST CIRCUIT SCHEMATICS

I. Synchro Transmitter (CX)

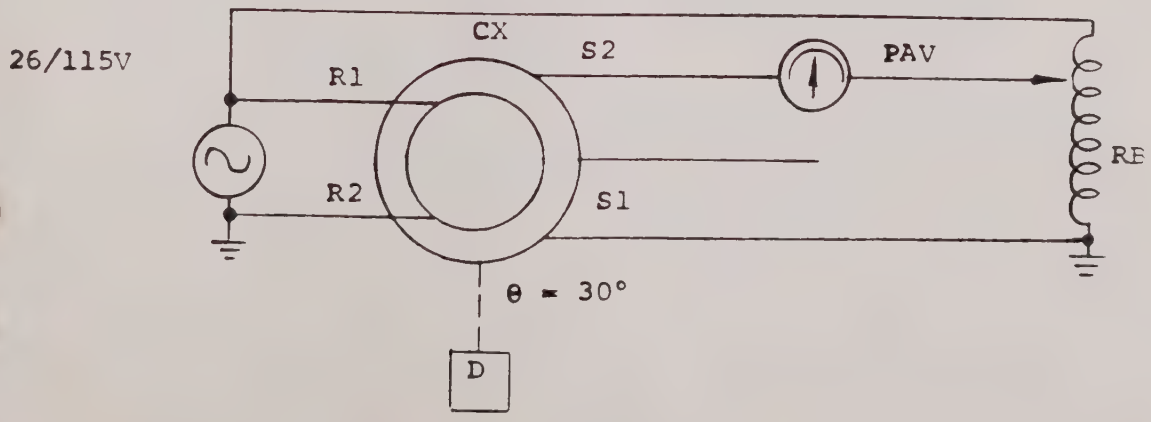
A. Angular Accuracy



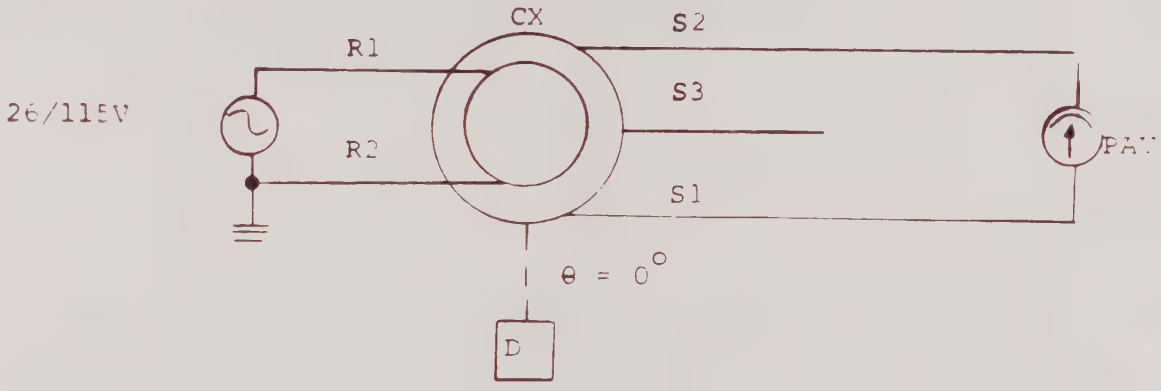
B. Null Test



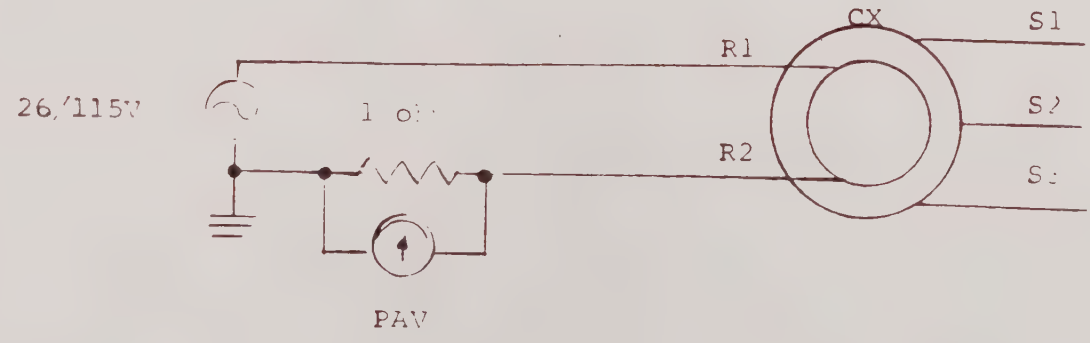
C.. Transformation Ratio Test



D. Phase Shift Test



E. Input Current Test



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II. Synchro Differential Transmitter (CDX) Test

A. Phasing, Electrical Zero, and Angular Accuracy Test

1. Set up circuit A-1 as indicated.

2. Set 530 and 540 to 0°.

3. Rotate CDX shaft counterclockwise, as viewed from the shaft end, until the meter reads zero. Note that the needle approaches zero from left to right. For 115V excitation, use 100V range of the voltmeter. For 26V excitation, use 30V range of the voltmeter.

4. With synchro shaft at null, switch the 540 to 5°. The voltmeter should deflect to the left. Return to 0°.

5. Switch 530 to 5°. The voltmeter should deflect to the left. Return the 530 to 0°.

6. If the requirements of Steps 3,4, and 5 are met, the phasing is correct, and the null point is electrical zero.

7. Mount CDX in the dividing head.

8. With the dividing head at 0, CDX must be at electrical zero, as defined by Steps 3 through 5.

9. Set voltmeter Function Selector to 90°.

10. Set 540 to 90°.

11. Rotate the Phase Angle Dial until quadrature null is reached.

12. The angle read on the Phase Angle Dial is approximately equal to the phase shift of the CDX.

13. With the Phase Angle Dial left at this setting, return the 540 and the Function Selector to 0°.

14. Re-zero CDX in the dividing head if necessary.

15. With the CDX at zero, offset dividing head by an amount equal to the maximum allowable error of the CDX.

16. Down scale the Range Selector until the first off scale meter reading is reached. Turn the Range Selector to the next up-scale range. Record the deflection noted on the PAV. This is the maximum allowable error voltage.

17. Return dividing head to 0°.

18. Advance the 530 and the dividing in the required increments. The null as noted on the PAV should be less than that obtained in Step 16.

19. Set up circuit A-2 indicated with CDX still mounted in the dividing head.

20. Check that CDX is zero and dividing head is set to zero.

21. Advance the 530 and the dividing head in the required increments. The null error as noted on the PAV should be less than that obtained in step 16.

B. Null Test, Fundamental and Total

1. Set up circuit as indicated.
2. Attach PAV leads to R1 and R2.
3. Set 530 to 120° and dividing head to 0°.
4. Set voltmeter Function Selector to 0° and adjust dividing head vernier for a null.
5. In the Total and Fundamental positions of the Function Selector, read the respective nulls.
6. Set 530 to 240° and dividing head to 120°.
7. Repeat Steps 4 and 5.
8. Set 530 to 0° and dividing head to 240°.
9. Repeat Steps 4 and 5.
10. Attach PAV leads to R2 and R3.
11. Set 530 to 240° and dividing head to 0°.
12. Repeat Steps 4 and 5.
13. Set 530 to 0° and dividing head to 120°.
14. Repeat Steps 4 and 5.
15. Set 530 to 120° and dividing head to 240°.
16. Repeat Steps 4 and 5.
17. Attach PAV leads to R1 and R3.
18. Set 530 to 120° and dividing head to 0°.
19. Repeat Steps 4 and 5.

20. Set 530 and dividing head to 120°, and repeat Steps 4 and 5.

21. Set 530 and dividing head to 240°, and repeat Steps 4 and 5.

C. Transformation Ratio Test

1. Set up circuit indicated.

2. Set Phase Angle Dial to 0°.

3. Set dividing head to 30°.

4. Switch voltmeter Function Selector to 0°.

5. Set Ratio Box for a null on the voltmeter.

6. Record ratio reading.

7. Transformation ratio is obtained by dividing in-phase ratio by cos 30° (.866).

D. Phase Shift Test

1. Set up circuit indicated.

2. Set Function Selector to 90°.

3. Set dividing head to 30° and rotate Phase Angle Dial for quadrature null.

4. The phase shift of the CDX may be read directly from the Phase Angle Dial.

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E. Input Current Test

1. Set up circuit indicated.

2. Switch voltmeter Function Selector to Total.

3. The input current of the CDX is read directly in amperes on the voltmeter, i.e., .1 volts = .1 amperes.

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20. Set 530 and dividing head to 120°, and repeat Steps 4 and 5.

21. Set 530 and dividing head to 240°, and repeat Steps 4 and 5.

C. Transformation Ratio Test

1. Set up circuit indicated.

2. Set Phase Angle Dial to 0°.

3. Set dividing head to 30°.

4. Switch voltmeter Function Selector to 0°.

5. Set Ratio Box for a null on the voltmeter.

6. Record ratio reading.

7. Transformation ratio is obtained by dividing in-phase ratio by cos 30° (.866).

D. Phase Shift Test

1. Set up circuit indicated.

2. Set Function Selector to 90°.

3. Set dividing head to 30° and rotate Phase Angle Dial for quadrature null.

4. The phase shift of the CDX may be read directly from the Phase Angle Dial.

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E. Input Current Test

1. Set up circuit indicated.

2. Switch voltmeter Function Selector to Total.

3. The input current of the CDX is read directly in amperes on the voltmeter, i.e., .1 volts = .1 amperes.

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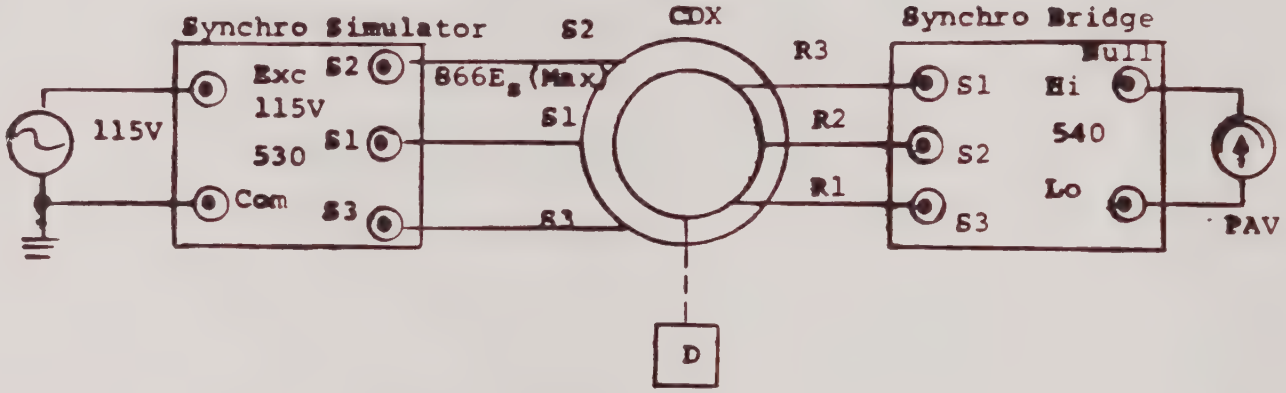
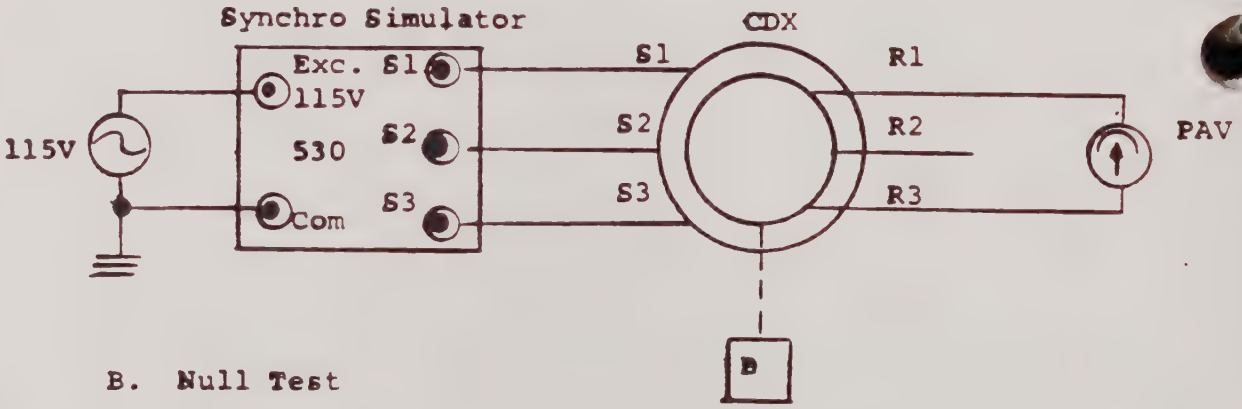
II. Synchro Differntial Transmitter (CDX)

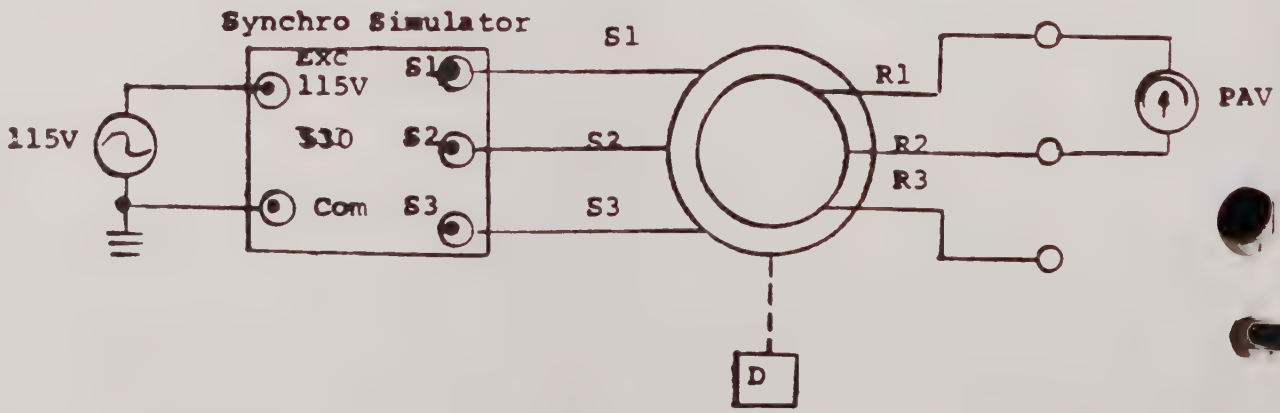
A1 Angular Accuracy (Rotor)



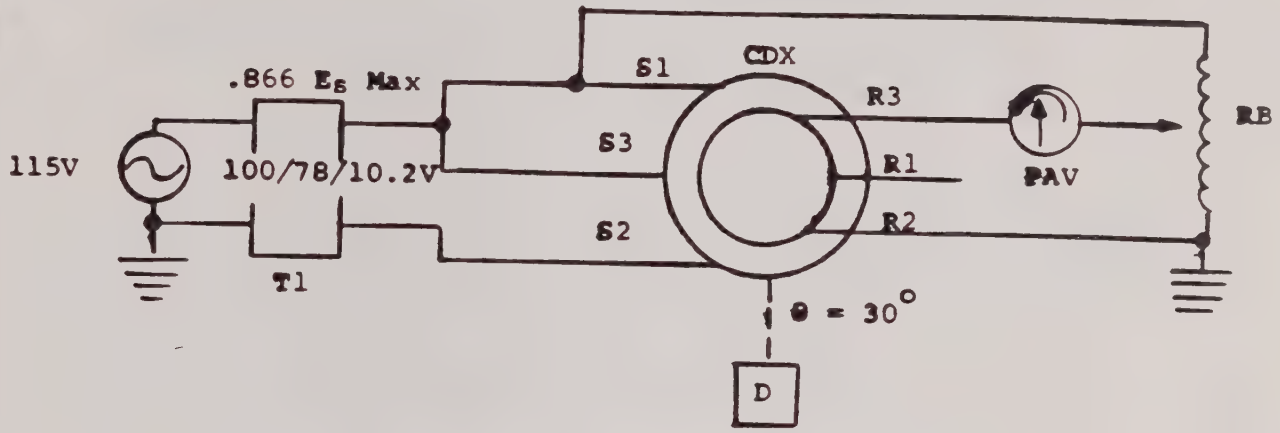
A2 Angular Accuracy (Stator)



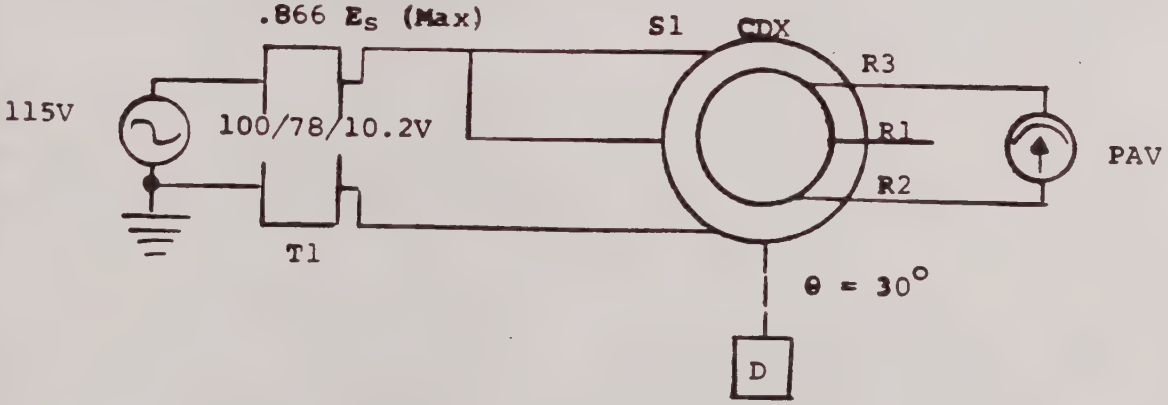
B. Null Test



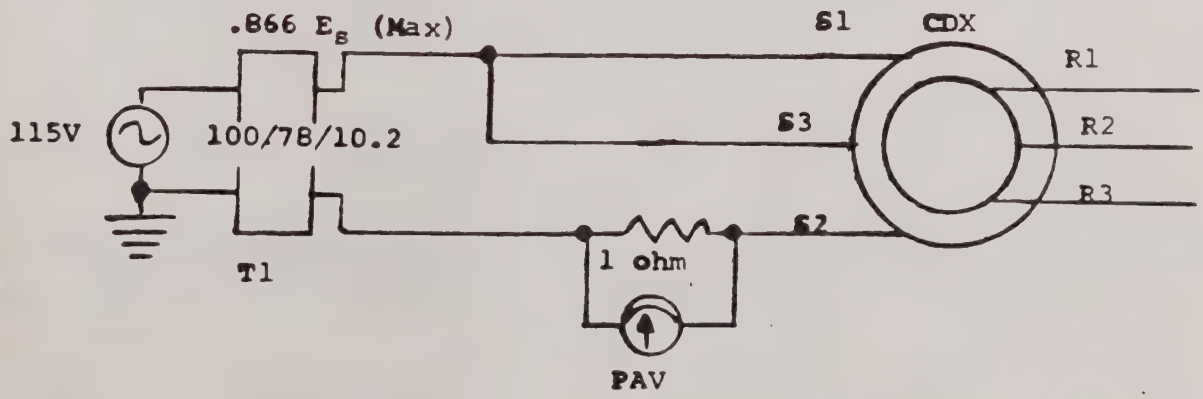
C. Transformation Ratio Test



D. Phase Shift Test



E. Input Current Test



III. Synchro Transformer (CT) Test

A. Phasing, Electrical Zero, and Angular Accuracy

1. Set up circuit indicated
2. Set S30 to 0°.
3. Rotate CT shaft counterclockwise, as viewed from the shaft end, until the meter reads zero. Note that the needle approaches zero from left to right. For 115V or 90V excitation, use the 100V range of the voltmeter. For 11.8V excitation, use the 10V range of the voltmeter.
4. With synchro shaft at the null point, switch S30 to 5°. The voltmeter should deflect to the left.
5. Return the S30 to 0°.
6. If the requirements of Steps 3 and 4 are met, the phasing is correct, and the null point is electrical zero.
7. Mount the CT in the dividing head.
8. With the dividing head at 0°, CT must be at electrical zero, as defined in Test 3 and 4.
9. Set voltmeter Function Selector to 90°.
10. Set S30 to 90°.
11. Rotate the Phase Angle Dial until quadrature null is reached.
12. With Phase Angle Dial left at this setting, return the S30 to 0°, and set the Function Selector to 0°.

13. Re-zero CT in the dividing head if necessary.

14. With CT at zero, offset dividing head by an amount equal to the maximum allowable error of the CT.

15. Down scale the Range Selector until the off-scale meter reading is reached. Turn the Range Selector to the next up-scale range. Record the deflection noted on the PAV. This is the maximum allowable error voltage.

16. Return the dividing head to 0°.

17. Advance the 530 and the dividing head in the required increments. The null error as noted on the PAV should be less than that obtained in Step 15.

B. Null Test, Fundamental And Total

1. Set up circuit as indicated.

2. Set 530 and dividing head to 0°.

3. Set the voltmeter Function Selector to 0° and adjust dividing head vernier for a null.

4. Read the null in the Total and Fundamental position of the Function Selector.

C. Transformation Ratio Test

1. Set up circuit as indicated

2. Turn Phase Angle Dial to 0°.

3. Set dividing head to 270°.

4. Set voltmeter Function Selector to 0°.

5. Adjust Ratio Box for a null on the meter.

6. Record Ratio Box reading.

7. Transformation ratio is obtained by dividing in-phase ratio by cos 30° (.866).

D. Phase Shift Test

1. Set up circuit indicated.

2. Set voltmeter Function Selector to 90°.

3. With dividing head at 270°, rotate Phase Angle Dial on the voltmeter for a null.

4. The phase shift of the CT may be read directly from the Phase Angle Dial.

E. Input Current Test

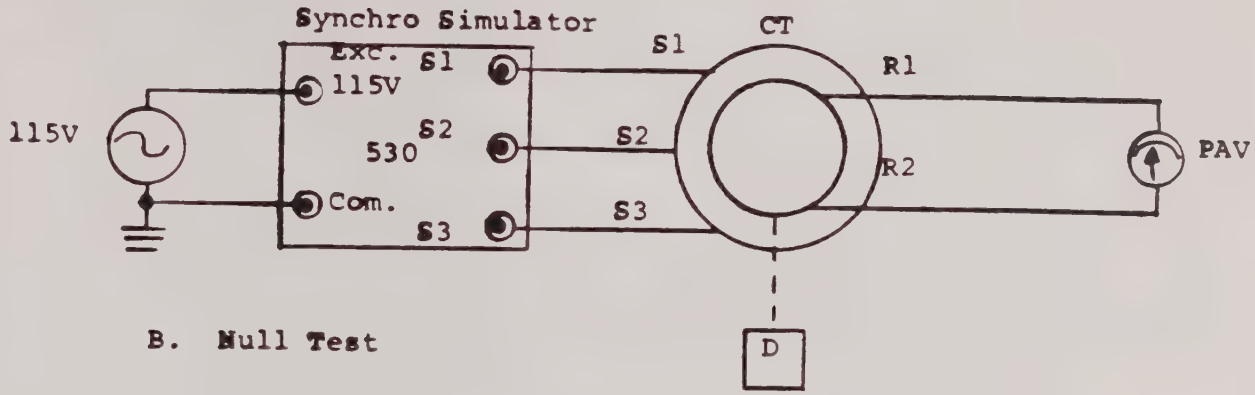
1. Set up circuit as indicated.

2. Set voltmeter Function Selector to Total.

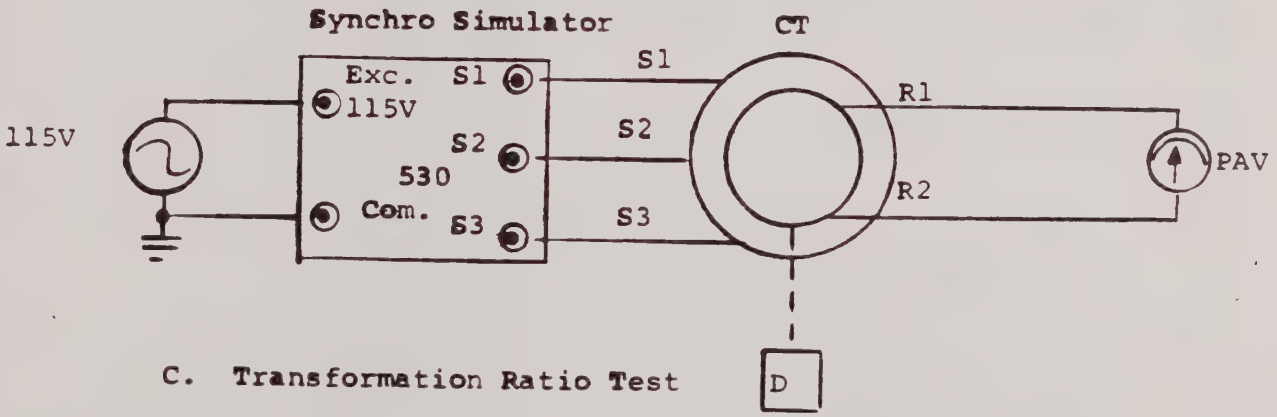
3. The input current of the CT is read directly in amperes on the voltmeter, i.e., .1V = .1 amperes.

III. Synchro Transformer (CT)

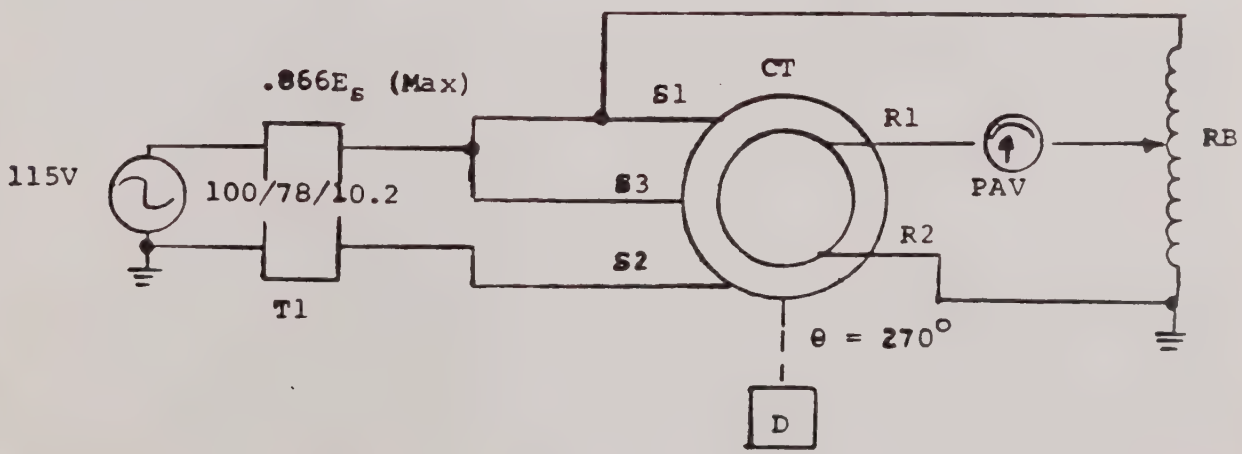
A. Angular Accuracy



B. Null Test



C. Transformation Ratio Test



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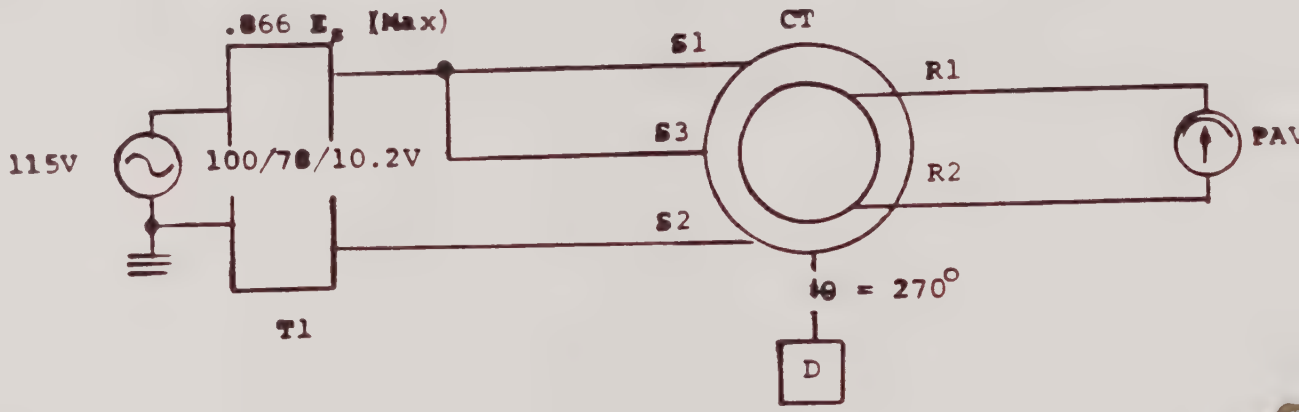
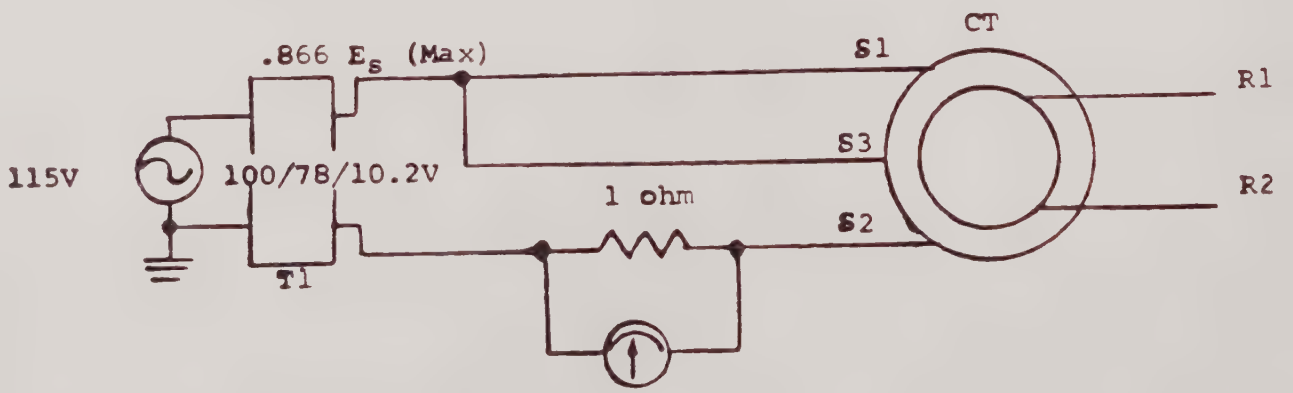
D. Phase Shift Test



E. Input Current Test



IV. Resolver Transmitter (RX)

A. Phasing, Electrical Zero, and Angular Accuracy

1. Set up circuit indicated.

2. Set 540 to 0°.

3. Rotate RX shaft counterclockwise, as viewed from the shaft end, until meter reads zero. Note that the needle approaches zero from right to left.

4. For 115V excitation, use 100 volt range of the voltmeter. For 26V excitation, use 30 volt range of the voltmeter.

5. With resolver shaft at the null point, switch 540 to 5°.

6. Return the 530 to 0°.

7. If the requirements of Steps 3 and 5 are met, the phasing is correct, and the null point is electrical zero.

8. Mount RX in a dividing head.

9. With the dividing head at 0°, RX must be at electrical zero as described in Steps 3 and 5.

10. Set voltmeter Function Selector to 90°.

11. Set 540 to 90°.

12. Rotate Phase Angle Dial until quadrature null is reached.

13. The angle read on the Phase Angle Dial is approximately equal to the phase shift of the RX.

14. With the Phase Angle Dial left at this setting, return the 540 and the Function Selector to 0°.

15. Re-zero the CX and the dividing head if necessary.

16. With RX at zero, offset the dividing head by the maximum allowable error.

17. Down-scale the Range Selector until the first off-scale meter reading is reached. Turn the Range Selector to the next up-scale range. Record the deflection noted on the PAV. This is the maximum allowable error voltage.

18. Return the dividing head to 0°.

19. Advance 540 and the dividing head in the required increments. The null error as noted on the PAV should be less than that obtained in Step 17.

B. Null Test, Fundamental and Total

1. Set up circuit indicated.

2. Set the dividing head to 0°.

3. Set Function Selector to 0°, and adjust dividing head vernier for a null.

4. Read null in Total and Fundamental positions of the Function Selector.

5. Attach the voltmeter leads to S2 and S4 and rotate dividing head to 90°.

6. Repeat Steps 3 and 4.

C. Transformation Ratio Tests

1. Set up circuit indicated.

2. Turn voltmeter Phase Angle Dial to 0°.

3. Turn voltmeter Function Selector to 0°.

4. Set dividing head to 0°, and adjust Ratio Box for a null.

5. Record ratio reading (transformation ratio).

D. Input Current

1. Set up circuit as indicated.

2. Set voltmeter Function Selector to Total.

3. The input current of the RX is read directly in amperes on the voltmeter, i.e., .1 volts = .1 amperes.

E. Phase Shift Test

1. Set up circuit indicated

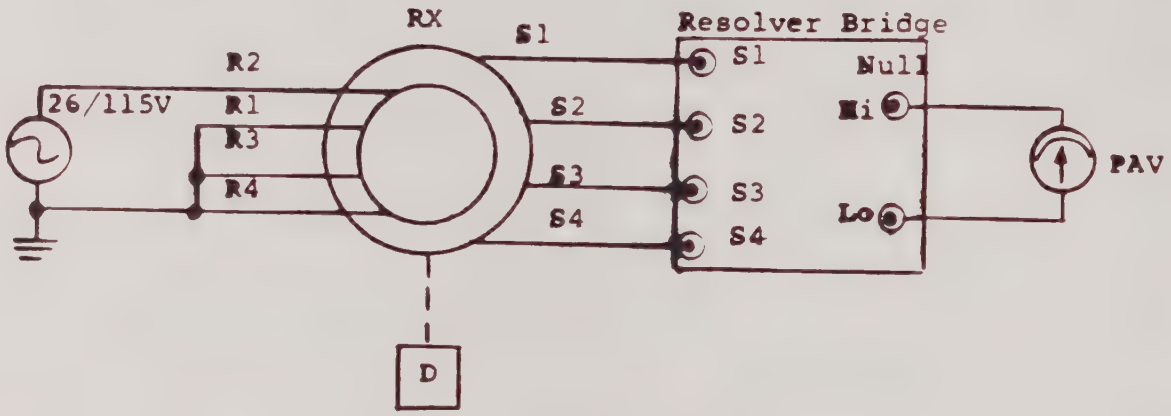
2. Set Function Selector at 90°.

3. With the dividing head at 0°, rotate the phase angle dial on the voltmeter for a null.

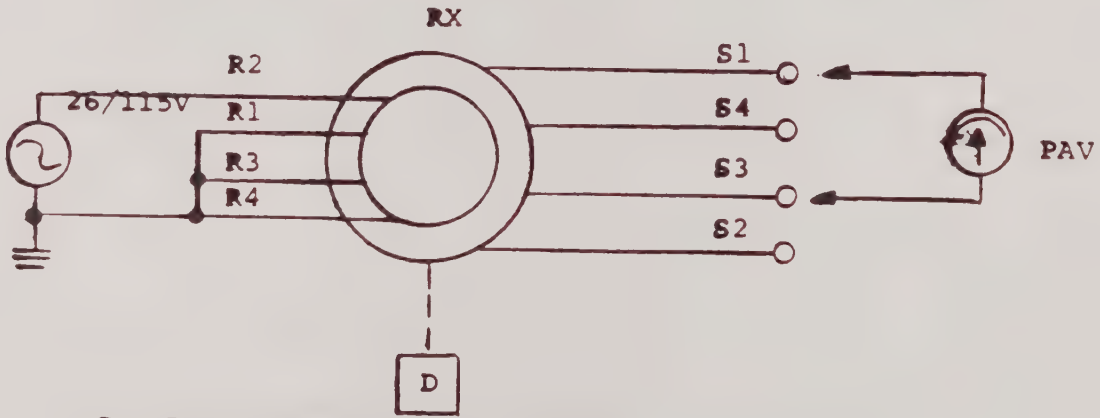
4. The phase shift of the RX may be read directly from the phase angle dial.

IV. Resolver Transmitter (RX)

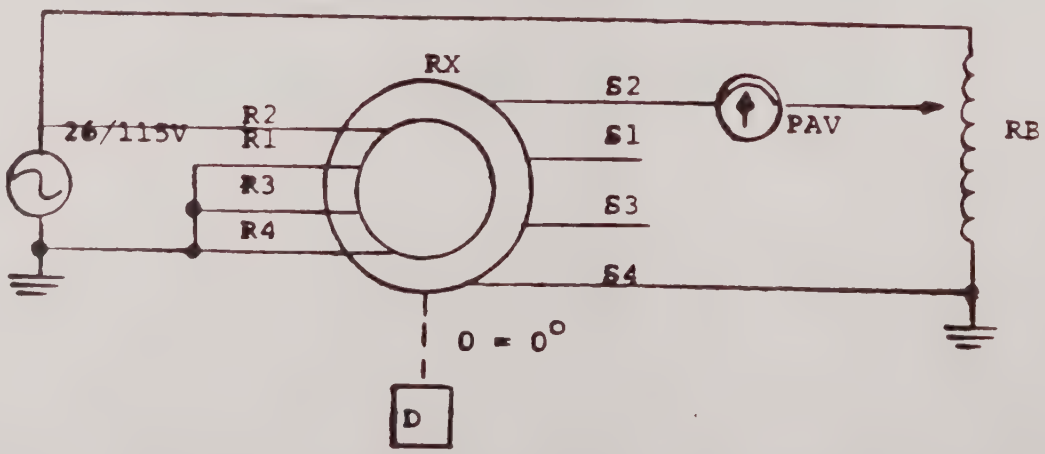
A. Angular Accuracy Test



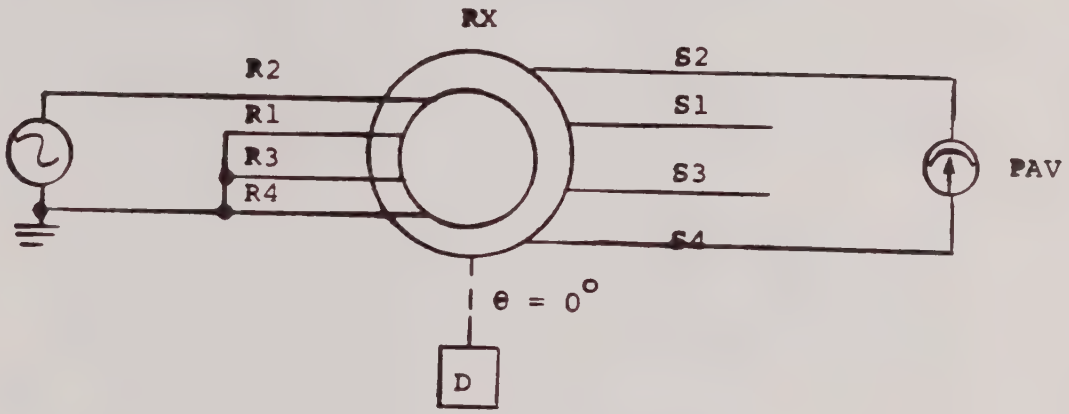
B. Null Test



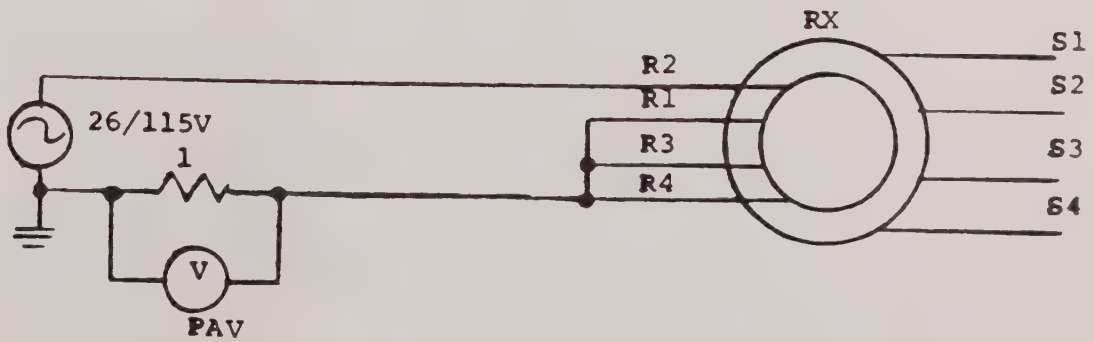
C. Transformation Ratio Test



D. Phase Shift Test



E. Input Current Test



V. Differential Resolver and Transformer (RD/RC) Tests

A. Phasing, Electrical Zero, and Angular Accuracy

1. Set up circuit A-1 as indicated.

2. Set the 530 and 540 to 0°.

3. Turn control panel power on, and rotate RD/RC shaft counterclockwise as viewed from the shaft end until the meter reads 0. Note that the needle approaches zero from left to right. For 115V excitation, use 100V range of the voltmeter. For 11.8V excitation, use 10V range of the voltmeter.

4. With RD/RC shaft at null point, switch 540 to 5°.

5. The voltmeter should deflect to the left. Return 540 to 0°.

6. Switch 530 to 5°. The meter should deflect to the left.

7. Return 530 to 0°.

8. If the requirements of Steps 3-6 are met, phasing is correct, and the null point is electrical zero.

9. Mount RD/RC in a dividing head.

10. With the dividing head at 0, RD/RC must be at electrical zero as described in Steps 3-6.

11. Set 530 to 90°.

12. Set Voltmeter Function Selector to 90°.

13. Rotate Phase Angle Dial until quadrature null is reached.

14. The angle read on the Phase Angle Dial is approximately equal to the phase shift of the RD/RC.

15. Re-zero the RD/RC in the dividing head if necessary.

16. With the RD/RC at zero, offset the dividing head by an amount equal to the maximum allowable error of the RD/RC.

17. Down scale the Range Selector until the first off-scale meter reading is reached. Turn the Range Selector to the next up-scale range. Record the deflection noted on the PAV. This is the maximum allowable error voltage.

18. Return the dividing head to 0°.

19. Advance 540 and the dividing head the required increments. The null error as noted on the PAV should be less than that obtained in Step 17.

20. Set up circuit A-2 as indicated.

21. Re-zero the RD in the dividing head if necessary.

22. Advance 530 and the dividing head in the required increments. The null error as noted on the PAV should be less than that obtained in Step 17.

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200 terminal drive, plainview, n. y. OVerbrook 1-8600

B. Null Test, Fundamental and Total

1. Set up circuit indicated.
2. Set 530 and dividing head to 0°
3. Set the Function Selector to 0°, and adjust the dividing head vernier for a null.
4. Read the null in both Total and Fundamental positions of the Function Selector.
5. Set 530 and dividing head to 90°.
6. Repeat Steps 3 and 4.
7. Attach voltmeter leads to R2 and R4
8. Set 530 to 90° and dividing head to 0°.
9. Repeat Steps 3 and 4.
10. Set 530 to 0° and dividing head to 90°.
11. Repeat Steps 3 and 4.

C. Transformation Ratio Test

1. Set up circuit indicated.
2. Turn Phase Angle Dial to 0°.
3. Turn voltmeter Function Selector to 0°.
4. Set dividing head to 0°.
5. Adjust Ratio Box for a null on the voltmeter.

6. Record Ratio Box reading (transformation ratio).

D. Phase Shift Test

1. Set up circuit indicated.

2. Set voltmeter Function Selector to 90°.

3. With the dividing head at 0°, rotate the Phase Angle Dial on the voltmeter for a null.

4. The phase shift of the RD/RC may be read directly from the Phase Angle Dial.

E. Input Current Test

1. Set up circuit indicated.

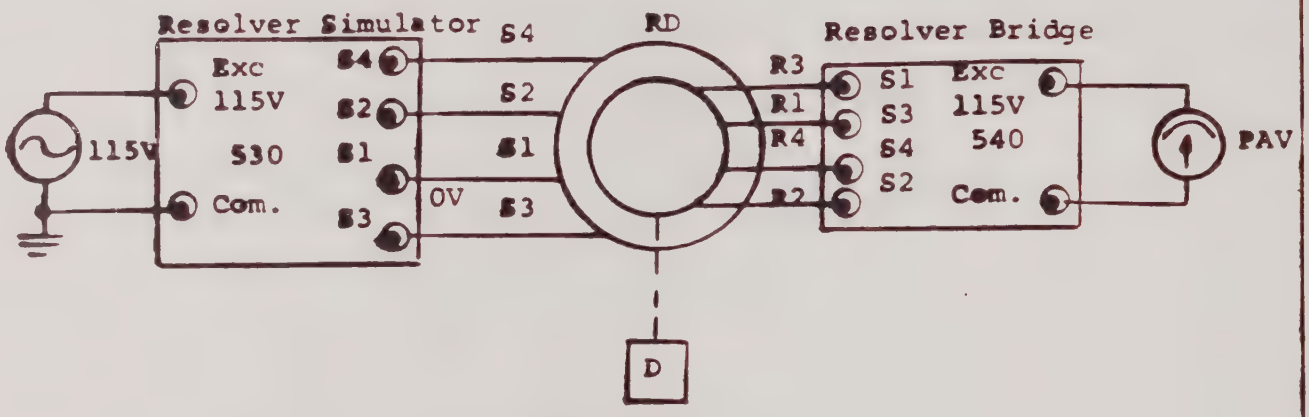
2. Set voltmeter Function Selector to Total.

3. The input current of the RD/RC is read directly in amperes on the voltmeter, i.e., .1 volt - .1 amperes.

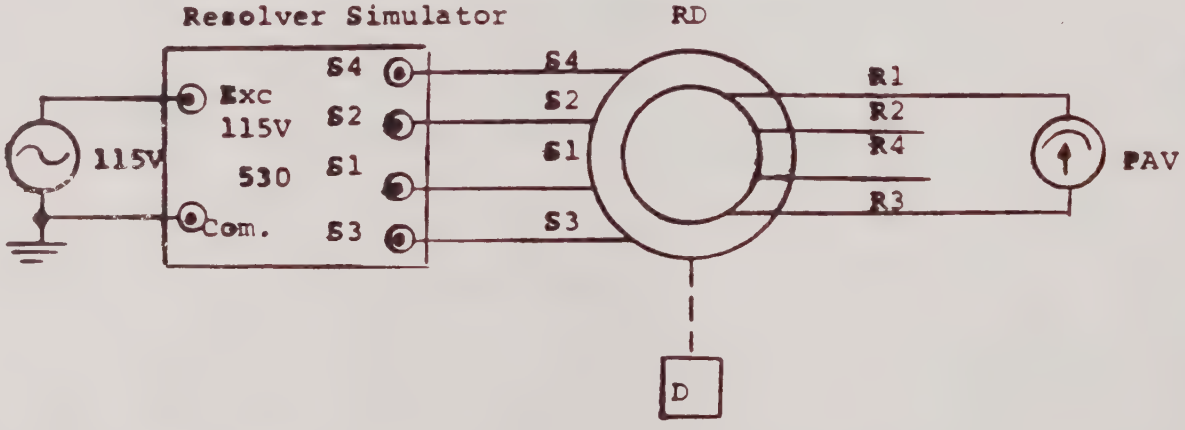
NORTH ATLANTIC industries, inc.
200 terminal drive, plainview, n. y. (Overbrook 1-8600)

V. Resolver Differential Transmitter or Transformer (RD/RC)

A1 Angular Accuracy (RD Rotor)

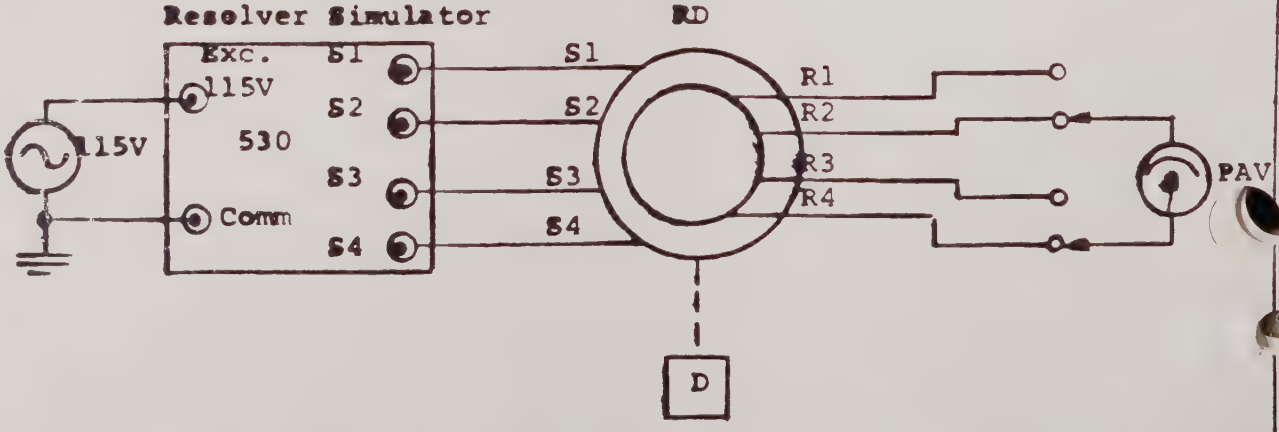


A2 Angular Accuracy (RD and RC Stator)

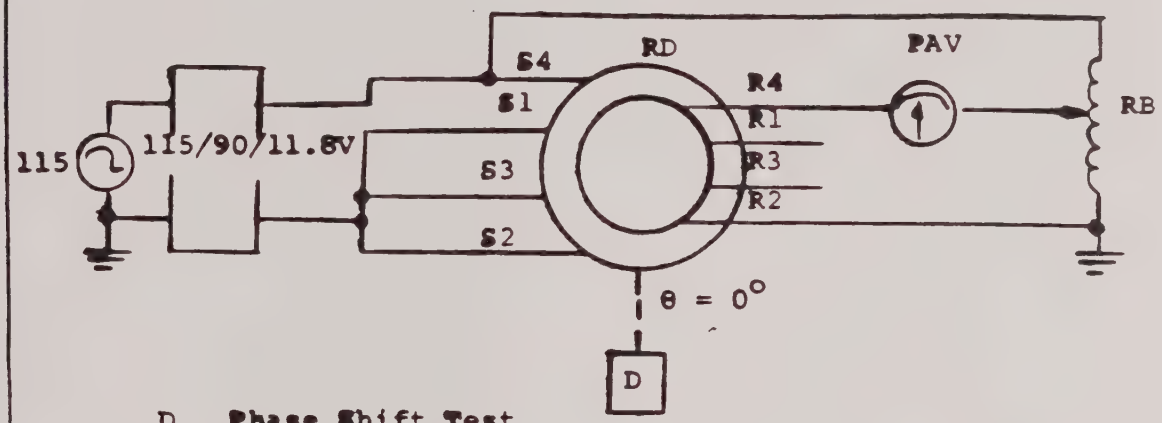


B Null Test

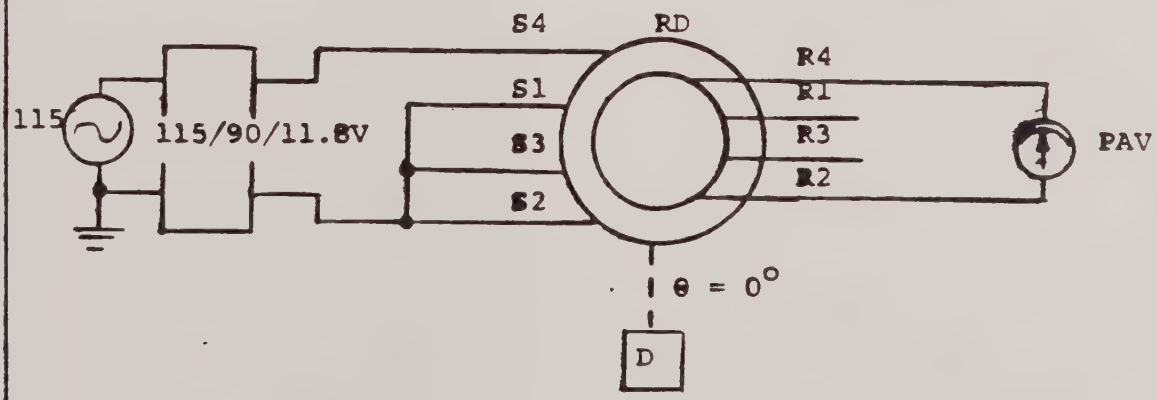
Resolver Simulator



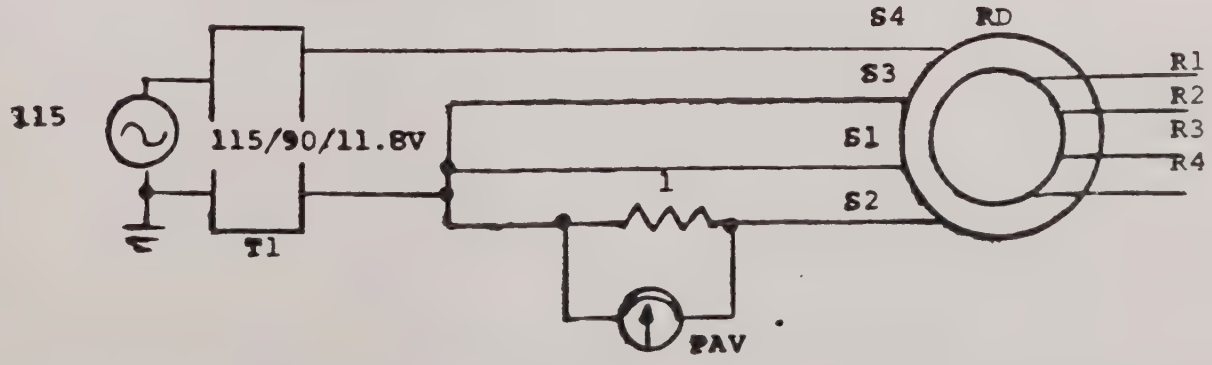
C. Transformation Ratio Test



D. Phase Shift Test



E. Input Current Test



SECTION IX

REPLACEMENT PARTS LIST

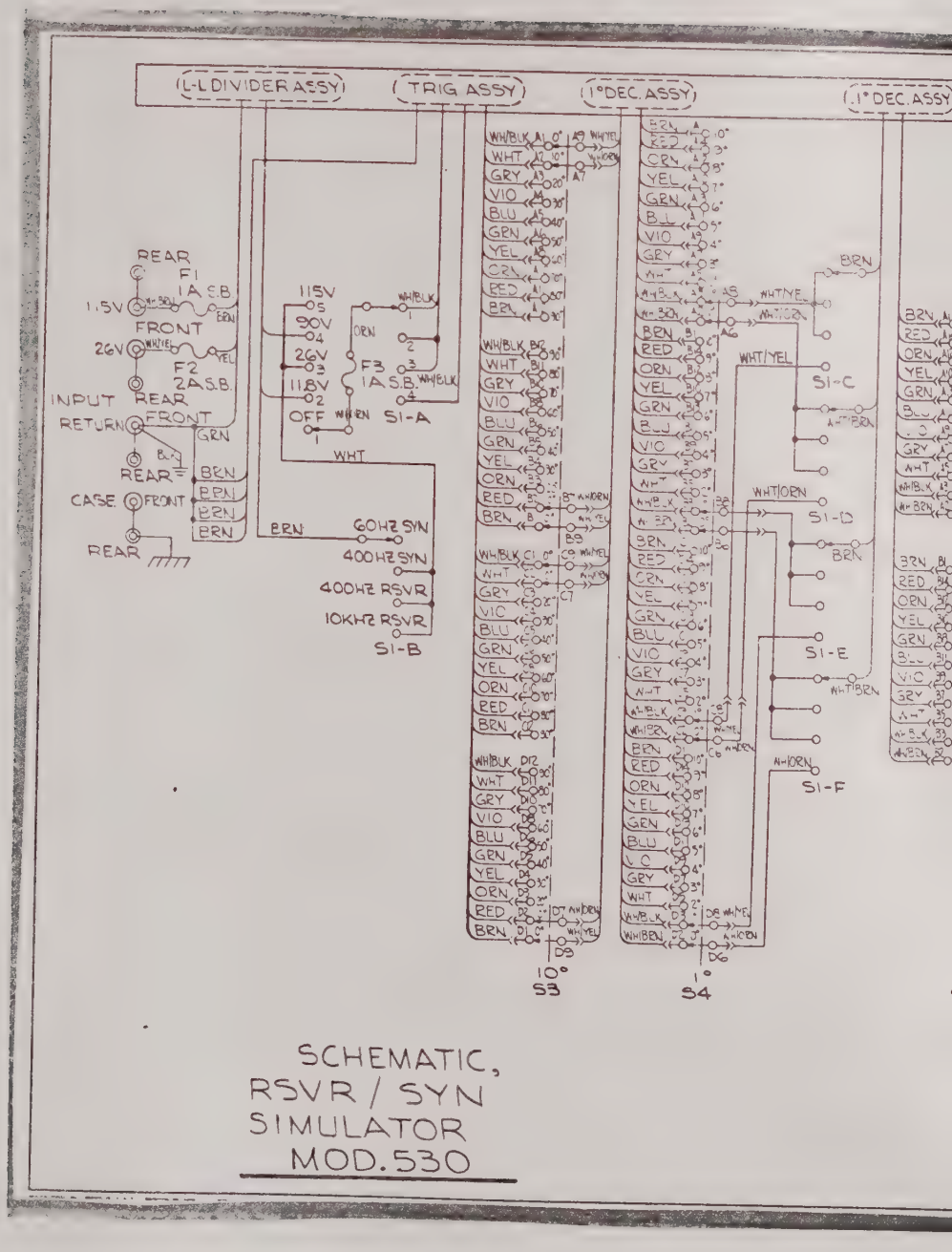
REPLACEMENT PARTS LIST

DESIGNATION	DESCRIPTION	NAI PART NO.	TOTAL QTY.
	RSVR SYN. SIMULATOR ASSEMBLY	782777	
F1, F3	Fuse, 1A, SLO BLO	803876	2
F2	Fuse, 2A, SLO BLO	800935	1
S1	Switch, Mode	804678	1
S2	Switch, L-L Level	804679	1
S3	Switch Assembly, 10°	C-782782	1
S4	Switch Assembly, 1°	C-782163	1
S5	Switch Assembly, .1°	C-782164	1
S6	Switch Assembly, .01°	C-782173	1
S7	Switch Assembly, .001°	C-782308	1
T1	Transformer Can Assembly	782780	1
XF1, XF2, XF3	Fuseholder	804723	3
TB1, TB2	Terminal Strip	804540	2
	Binding Post, Red	800119	6
	Binding Post, Black	800120	1
	Binding Post, Ground	800546	1
	Knob, Bar	201979	5
	Knob, Pointer	201722	1

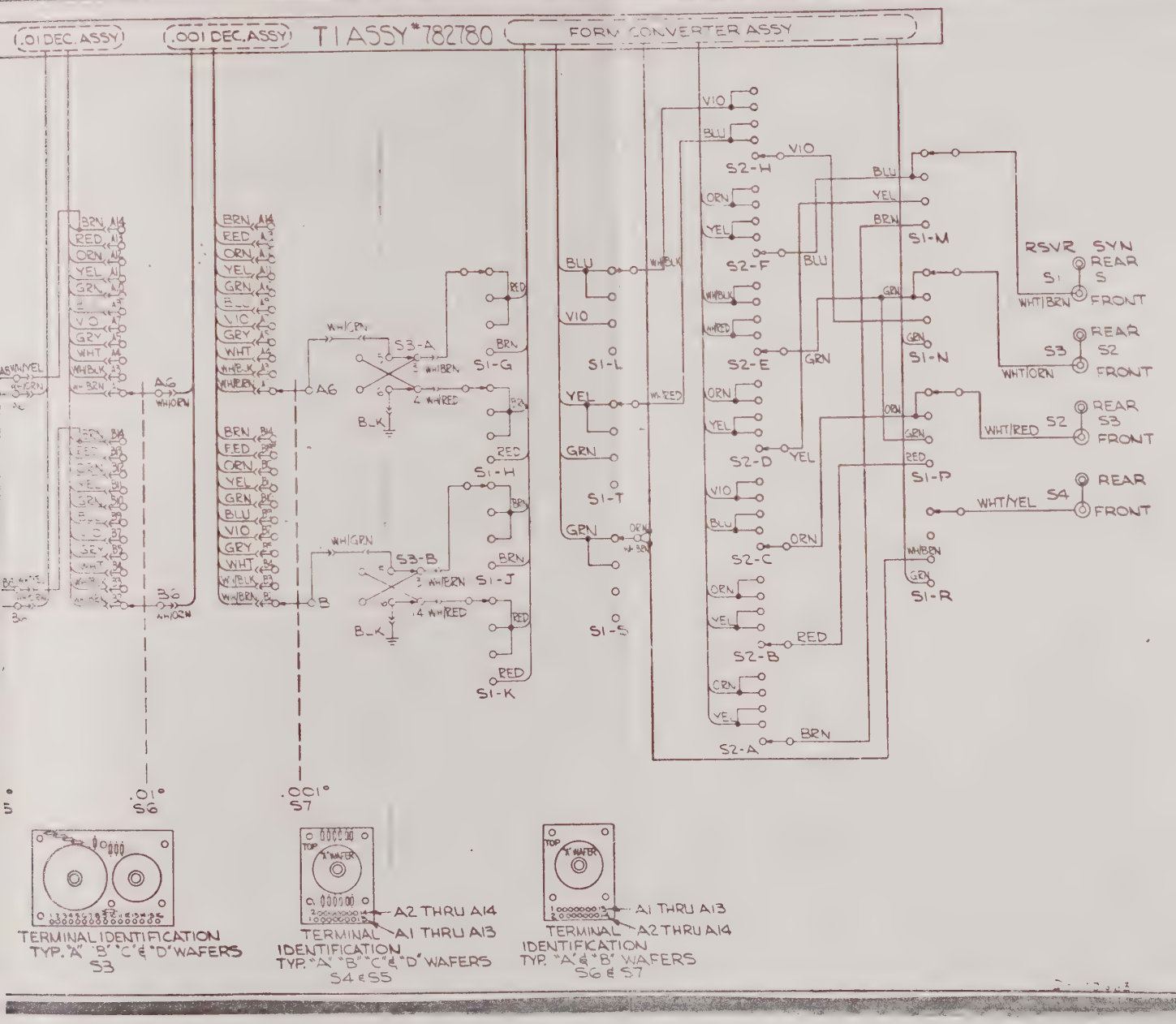
Consistent with North Atlantic Industries' policy of continuously up-grading components and improving circuits, we reserve the right to substitute components which are functionally interchangeable for any of the parts shown above.

SECTION X

SCHEMATICS



SCHEMATIC,
RSVR / SYN
SIMULATOR
MOD. 530


(.01 DEC. ASSY)
(.001 DEC. ASSY)
T1 ASSY*782780
FORM CONVERTER ASSY
S3-A
S3-B
S1-G
S1-H
S1-J
S1-K
S1-L
S1-T
S1-S
S1-M
S1-N
S1-P
S1-R
S2-H
S2-F
S2-E
S2-D
S2-C
S2-B
S2-A
RSVR SYN
S1 REAR S FRONT
S3 REAR S2 FRONT
S2 REAR S3 FRONT
S4 REAR FRONT
WHT/BRN
WHT/ORN
WHT/RED
WHT/YEL
.01° S6
.001° S7
TERMINAL IDENTIFICATION TYP. "A" "B" "C" & "D" WAFERS S3
TERMINAL IDENTIFICATION TYP. "A" "B" "C" & "D" WAFERS S4 & S5
TERMINAL IDENTIFICATION TYP. "A" & "B" WAFERS S6 & S7
A2 THRU A14
A1 THRU A13
A1 THRU A13
A2 THRU A14

WARRANTY

A. The Seller warrants Products against defects in material and workmanship for one year from the date of original shipment. The Seller's liability is limited to the repair or replacement of Products which prove to be defective during the Warranty period. There is no charge under the Warranty except for transportation charges. The Purchaser shall be responsible for Products shipped until received by the Seller.

B. The Seller specifically excludes from the Warranty 1) calibration, 2) fuses, and 3) normal mechanical wear, eg, end-of-life on assemblies such as switches, relays, gear trains, etc. is dependent upon number of operations or hours of use, and end-of-life may occur within the Warranty period.

C. The Seller is not liable for consequential damages or for any injury or damage to persons or property resulting from the operation or application of Products.

D. The Warranty is voided if there is evidence that Products have been operated beyond their design range, improperly installed, improperly maintained or physically mistreated.

E. The Seller reserves the right to make changes and improvements to Products without any liability for incorporating such changes or improvements in any Products previously sold, or for any notification to the Purchaser prior to shipment. In the event the Purchaser should require subsequently manufactured lots to be identical to those covered by this Quotation, the Seller will, upon written request, provide a quotation upon a change control program.

F. No other Warranty expressed or implied is offered by the Seller other than the foregoing.

NORTH ATLANTIC industries, inc.
60 plant avenue, hauppauge, n. y. 11787 516582-6500

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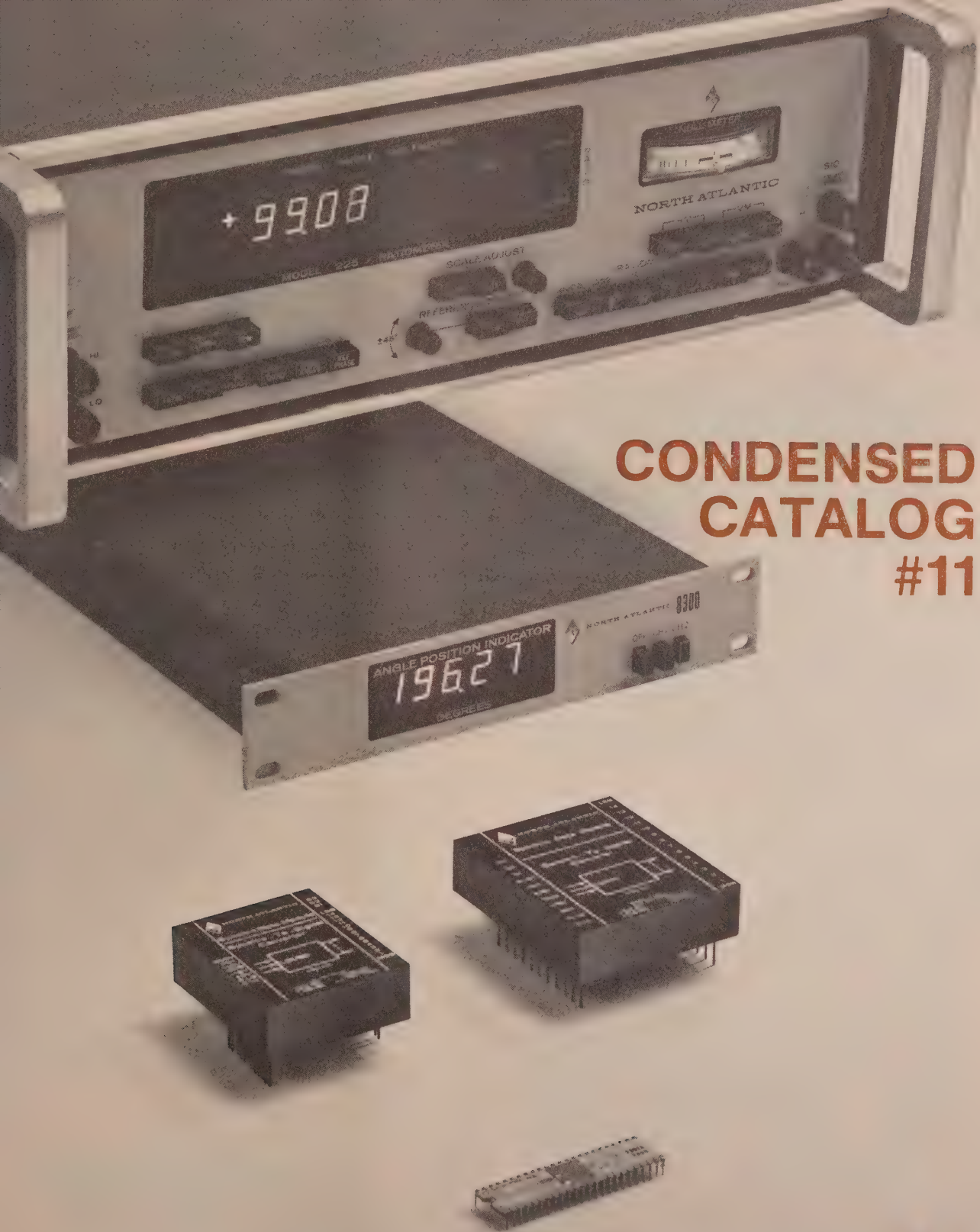


CONDENSED CATALOG #11

NORTH ATLANTIC

DIGITAL PHASE ANGLE VOLTMETERS

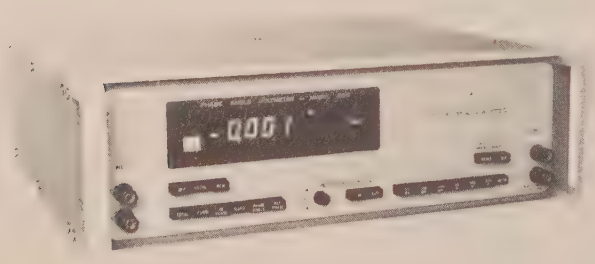
This series of instruments provides the digital equivalent of the well-known Phase Angle Voltmeter, but with significant increases in both precision and speed of measurement. Voltage measurements include total, fundamental, in-phase, and quadrature. Phase measurements are from 0° to 359.9°, and a +45° reference offset control is provided. Full-scale voltage ranges (10mV to 1000mV) and phase angle (359.9°) are directly read on a 4-½ digit display. Voltage ranges may be pushbutton selected or auto-ranged. All models provide for both manual and remote programming or optional 488 IB (IEEE-STD-488-1975) interface bus. Digital outputs include reading, mode, range and polarity information as well as data status signals. Long-term use of this instrument series is assured since field-change of frequency plug-in modules requires only a routine recalibration procedure.

Model 225
Digital Phase Angle Voltmeter

Designed for multi-frequency applications, the Model 225 is available with 1, 2, 3, or 4 pre-specified plug-in frequency modules (30Hz to 54KHz). They feature pushbutton selection of Voltage range (or auto-range), measurement mode and frequency range. Voltage accuracy is 0.05% and phase accuracy is 0.2°. Local/remote pushbutton selection permits remote programming of all functions for ATE use. Broadband signal isolation features 10M input impedance. A standard null meter is included for applications such as synchro nulling (full-scale adjust is an option).

Model 225/Ratiometer
Digital Phase Angle Voltmeter

Incorporating all of the 225 features (and options), an added ratiometric mode provides direct reading ratio ranges from .0002 to 20.00. Signal input voltages (numerator) from 1mV to 500V, and reference voltages (denominator) from 3V to 126V are accommodated. No adjustments are required, only selection of the proper signal range. Accuracy is a function of reading, range, and reference level, and accuracies to .2% are achievable.

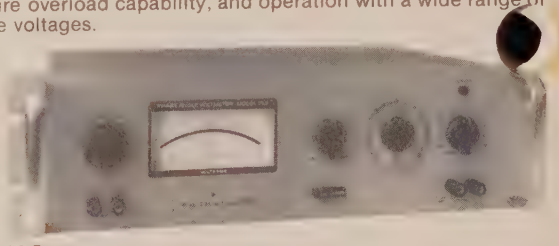


Model 220
Digital Phase Angle Voltmeter

Offered as a low-cost model for 400Hz production applications, the Model 220 is capable of the full range of voltage and phase measurements. It may be programmed remotely, and the digital outputs are provided. Optional signal isolation (10MΩ) is available.

PHASE ANGLE VOLTMETERS

These multifunctional instruments combine phase-sensitive m[illegible] with the functions of a conventional AC voltmeter operating ov[illegible] range of 10Hz to 100KHz. They provide direct-reading voltage measurement of the total, fundamental, in-phase and quadrature components of an AC signal to 2% full-scale, as well as phase angle to 1°. They feature calibrated voltage ranges of 300uV (or 1mV) to 300V rms full-scale, built-in or plug-in harmonic-rejection filters, high quadrature overload capability, and operation with a wide range of reference voltages.



Model 213C
Phase Angle Voltmeters

This solid-state instrument, successor to the famous VM-202, provides phase-sensitive measurement at a single pre-specified frequency from 30Hz to 10KHz with +5% frequency bandwidth (without adjustment). Full-scale measurement from 300uV to 300V. The Model 213C has signal and reference isolation.

Model 321
Broadband Phase Angle Voltmeter

The Model 321 combines in one instrument, a phase sensitive null detector, a phase sensitive voltmeter and a phase meter, operating over the frequency range of 10Hz to 100KHz. It's broadband characteristics make it ideally suited for use in amplifier and network design, vibration analysis, telemetry system measurements, biomedical research, and similar applications requiring the measurement of complex signals and their vector components over a broad range of frequencies

The model 321 incorporates proprietary circuit techniques that eliminate the use of reactive phase shifters and filters while maintaining accuracy, stability, and greater than 40 db harmonic rejection. In addition to phase angle; total, fundamental, in-phase and quadrature voltages can be measured with respect to an arbitrary phase-shifted reference. The reference can vary from 150mV to 150V without the need for calibration or adjustment. The 321's versatility, accuracy, and ease of use make it ideally suited or both laboratory and production line use.

ANGLE POSITION INDICATORS

Model 800
Synchro Panel Meter

The new Model 800 Synchro Panel Meter reaches a new level in the price/performance balance of synchro angle indicators. Designed [illegible] system or test set applications, the Model 800 features 0.1° resolut[illegible] and operates directly off the stator and rotor signals, requiring no separate power. With its type II tracking loop, the Synchro Panel Meter has full digital output and is available with 0 to 359.9, ±179.9 and 0 to 9999 ranges. It has ±2° offset adjust to allow for final system zeroing and pin programming for all standard synchro or resolver signals for maximum flexibility.

ANGLE POSITION INDICATORS

Model 8300
Angle Position Indicator

The Model 8300 offers a combination of LSI-enhanced reliability, cost, and features never before available in any angle position indicator. Through use of direct hard-wire programming in the mating rear connector mode and line-line are selected (resolver or snychro - 11.8V, 26V or 90V) for each of two front-panel pushbutton selected channels. Each of the two data channels may have independent references from 47Hz to 440Hz. Thus, one channel may read 11.8V, 400Hz resolver data and the other 90V, 60Hz synchro data. Absolute accuracy is .05° for data rates up to 5rps (1800°/second). Resolution is .01°. Digital outputs are 5-decade BCD data lines plus converter control and data status lines. Options include degrees/minutes display, +180° display, and higher accuracy (+0.03°).

Model 8310
Angle Position Indicator

The model 8310 is a bench top model of the 8300 featuring full front panel controls and input terminations, data freeze button, tilt stand and mounting ears for rack mounting (if desired).

Model 8800
Angle Position Indicator

The Model 8800 is a growth version of the basic model 8300 described above. Featuring resolution up to 0.001 (optional) and accuracy up to 0.003° (optional), the LSI based Model 8800 truly represents a major advance in synchro-to-digital converter technology. A full type II tracking servo, the 8800 can track synchros at speeds up to 1000°/sec. Phase sensitive detection inherently rejects unwanted harmonics and noise contained in the incoming signal. Built-in auto-phase correction further reduces the possibility of errors caused by quadrature and harmonics when reference and signal are out of phase. The 8800 accepts any standard line-to-line level *without* preselecting or preprogramming the input signal. This unique feature is due to an auto-ranging circuit that displays the applied input signal voltage level on the front panel. Two pushbutton front-panel selectable input channels are provided. BCD outputs, data freeze and converter busy signals make the unit ideal for ATE application. The display is a bright, easy-to-read, 0.55" gas discharge planar display coupled with our exclusive LAZY-EIGHT ambiguity indicator (discerns between real 8's and 8's due to jitter).

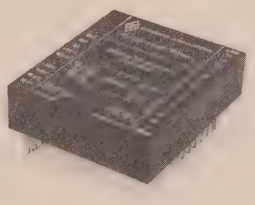
Model 8810
Angle Position Indicator

The Model 8810 is a bench top version of the model 8800 (above) featuring full front panel controls and input terminations, tilt stand and ears for rack mounting (if desired). Additionally, the Model 8810 is available with the 488 IB (IEEE STD 488-1975) interface bus for ATE applications.

SYNCHRO DATA MODULES

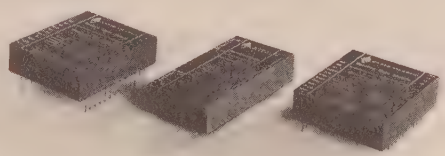
Series LSI/85
Snychro-To-Digital Modules

The 10-, 12- and 14-bit LSI/85 feature an industry-first use of LSI for improved operating reliability. Pin-compatible with DDC modules, synchro and resolver models feature 4-minute accuracy at data speeds to 3660°/second for 400Hz units and 500°/seconds for 60Hz units, line-line voltages of 11.8V, 26V, or 90V, 0° to 70°C operation (optional to 105°C). Built-in protection against improper power polarity, power transients and signal transients. Size: 3.125" x 2.625" x .82".



Series 785
Digital-To-Synchro Modules

The 14-bit Series 785 features 4-minute accuracy under full 1.25VA output load with a maximum 1% line-line variation for resolver and synchro models. Rated at 0° to 70°C (optional to 105°C), modules are fully protected against damage from overload or short-circuit. Size: (same as LSI/85): 3.125" x 2.625" x .82".



Series LSI/36
2 Speed
Synchro to Digital Modules

The North Atlantic LSI/36 two speed modular S/D converters are based on the use of LSI and 100 hr. burn-in to achieve higher inherent reliability than competitive units. Consisting of two independant type II tracking converters and a digital combiner, the LSI/36 offers single speed and multispeed comonality, high performance, and immunity from analog cross over instability common in some two speed S/D's. Full 19 bit resolution reduces the quantization error to less than 1.3 seconds.

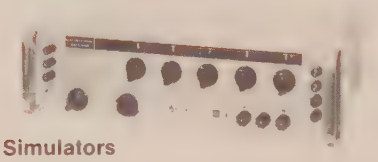
High performance specifications include tracking to 10 rps on fine speed shaft (400Hz) ±15 seconds maximum worst case error including combiner error, temperature and velocity error, power supply variations and quantization error. Two temperature ranges are available: 0°C to +70°C and -55°C to +100°C. Converter modules are full transient protected on the synchro or resolver lines while the ±15V are protected against power transients or voltage reversal. Std. units are for 1x, 36x speed ratios but other ratios are available. The encapsulated nature of these modules makes them ideal for severe industrial or military applications such as fire control, navigation, ATE or antenna positioning systems.

Series MSC/36
2 Speed
Digital Combiner

The MSC/36 two speed combiner accepts two binary angle words representing main shaft (x1) and vernier shaft (x36) and delivers a combined unambiguous main shaft angle output with a resolution of 19 bits. Input and output is TTL compatible and all operations are performed in parallel. No timing or control signals are required. Packaged in a 2 x 4 x .8 module the MSC/36 is available in 0°C to 70°C or-55°C to +100°C. Standard unit is for 1x, 36x speed ratio but alternate ratios are also available.

Many other versions of all series are available, eg, 2 speed, synchro/ACP, ACP/synchro, digital CT, digital CDX, high power D/S for TR applications, frequencies other than 60-400Hz, etc.

RESOLVER/SYNCHRO SIMULATORS & BRIDGES



Series 530
Resolver/Synchro Simulators

These simulators provide the ideal outputs for driving resolvers and synchros at 11.8, 26, 90 and 115V line-line voltages. These line-line voltages are all available with either 26V or 115V 400Hz excitation, and feature isolated input and output. Accuracy is 2 arc-seconds. Resolution is .0001°, with standard units 3½" full rack panel.

Model 530/20
Broadband Resolver/Synchro Simulator

The Model 530/20 features 10 arc-second accuracy at 60Hz, 400Hz, and 800Hz, and 20 arc-second accuracy at 10KHz. It is useable over the entire frequency band from 50Hz to 10KHz. This broadband frequency characteristic makes it an ideal instrument for test facilities desiring the maximum capability in each instrument.

Model 532
Low-Cost Synchro Simulator

Model 531
Low-Cost Resolver Simulator

Model 532 is a miniature synchro simulator offering precision performance in a small panel-mounted unit suitable for production test, ground support and similar systems. Direct simulation of 11.8V 400Hz line-line synchro transmitters (CX) is provided, with dial reading in 30° segments plus 5° increments selectable by sealed thumbwheel switches and accurate to 30 arc-seconds. Also available are a Model 532 with 90V line-line ouput, and a Model 531 with 26V resolver output. All models feature the same construction, display, and accuracy.

Model 540/10 & 540/11
Resolver/Synchro Bridges

These bridges permit direct measurement of resolver and synchro transmitters. They feature a constant null gradient output voltage, isolated input and output, and input impedance over 500K. The Model 540/10 features 2 arc-second accuracy at 400Hz, and the Model 540/11 2 arc-seconds over the band of 400Hz to 1000Hz. Standard resolution is .0001°. All units are provided in a 3½" full-rack panel.

Model 540/20
Broadband Resolver/Synchro Bridge

The Model 540/20 features 10 arc-second accuracy over most of the frequency band from 55Hz to 10KHz. Also featured is a constant null gradient voltage which permits deviation measurements by using a Phase Angle Voltmeter as the null detector.

SALES OFFICES

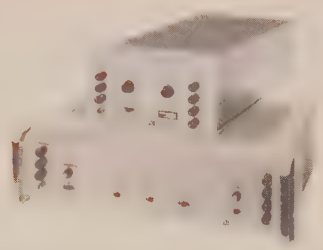
North Atlantic Sales Engineering Representatives are located in principal cities throughout the world. These representatives are available for consultation, can provide engineering data on any of the North Atlantic's products, or prepare technical and cost proposals for special requirements on computer interface equipment, phase sensitive instrumentation, resolver/synchro instrumentation and automatic test equipment. To locate the Sales Engineering Representative serving your area, please consult the current editions of EEM (Electronic Engineers Master), EBG (Electronic Buyers' Guide), Gold Book (Electronic Design), or contact our Sales Department.

SERVICE CENTERS

Factory service is available at authorized Service Centers in:

LOS ANGELES, CA
MINNEAPOLIS, MN
HAUPPAUGE, NY
LONDON, ENGLAND
MUNICH, GERMANY
PARIS, FRANCE
TEL AVIV, ISRAEL
TOKYO, JAPAN

DIGITAL TO RESOLVER/ SYNCHRO CONVERTERS



Series 538
Digital-To-Resolver/Synchro Converters

The Series 538 D/R-S Converters offer 9- to 17-bit single-speed resolution with digital input as binary angle. The input register is strobed and digital data is then held until the next strobe. The internal logic selects the appropriate trigonometric transformer taps, thus simulating actual 4-wire resolver or 3-wire synchro data at the selected line-line voltage. Built-in protection circuits are provided for power-line voltage and frequency transients, overload and short circuit. The Models 538/10 (full-rack) and 538/20 (half-rack) converters provide 14- to 17- bit resolution with better than 1-minute accuracy. Options include special input logic and multi-speed outputs. Converters are of all solid-state construction and feature output transformer isolation and short-circuit protection. All models accept 400Hz as the signal data frequency.

TECHNICAL SEMINARS

North Atlantic conducts a variety of technical seminars to acquaint system and test engineers with the technology and application of our instrumentation. These seminars are useful in suggesting solutions to particular instrumentation and interface problems. Conducted within your facility, these half- and one-day seminars follow prepared outlines and utilize workbooks. They are available without charge to interested companies. Your local North Atlantic Sales Engineering Representative will be pleased to describe availa[ble] subects and to schedule one or more of these seminars to su[it] convenience of your engineering staff

TECHNICAL BULLETINS

North Atlantic publishes a series of technical bulletins dealing with theoretical design and application aspects of instrumentation. Copies are available without charge from our Sales Department or from any North Atlantic Sales Engineering Representative.

NO. 101 AC SIGNAL MEASUREMENT FOR SUPPORT EQUIPMENT
NO. 102 RATIOMETRIC MEASUREMENTS: TECHNIQUES AND ACCURACIES
NO. 104 PHASE SENSITIVE CONVERSION APPLIED TO AUTOMATIC AC MEASUREMENT
NO. 107 MODERN METHODS OF EVALUATING SYNCHRO AND RESOLVER COMPONENTS
NO. 108 MEASURING AC RATIO AUTOMATICALLY
NO. 109 AC MEASUREMENT BY PHASE-SENSITIVE CONVERSION
NO. 110 HOW TO MEASURE PHASE-SENSITIVE NULL IN RATIO BRIDGES
NO. 111 EVOLUTION OF THE PHASE ANGLE VOLTMETER
NO. 112 CONVERTING MOTION TO DIGITAL DATA
NO. 113 SERVO-STYLE CIRCUIT SPEEDS SYNCHRO-TO-DIGITAL CONVERSION
NO. 114 APPLYING SERVO SYSTEMS TO GET HIGH-RESOLUTION READOUTS
NO. 115 SYNCHRO-TO-DIGITAL CONVERTERS: PICK THE ONE THAT DOES THE JOB
NO. 116 ACQUISITION OF SHAFT-ANGLE DATA
NO. 117 SYNCHRO RESOLVER-TO-DIGITAL CONVERSION COMPUTER INTERFACE
NO. 120 PHASE ANGLE VOLTMETERS.

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